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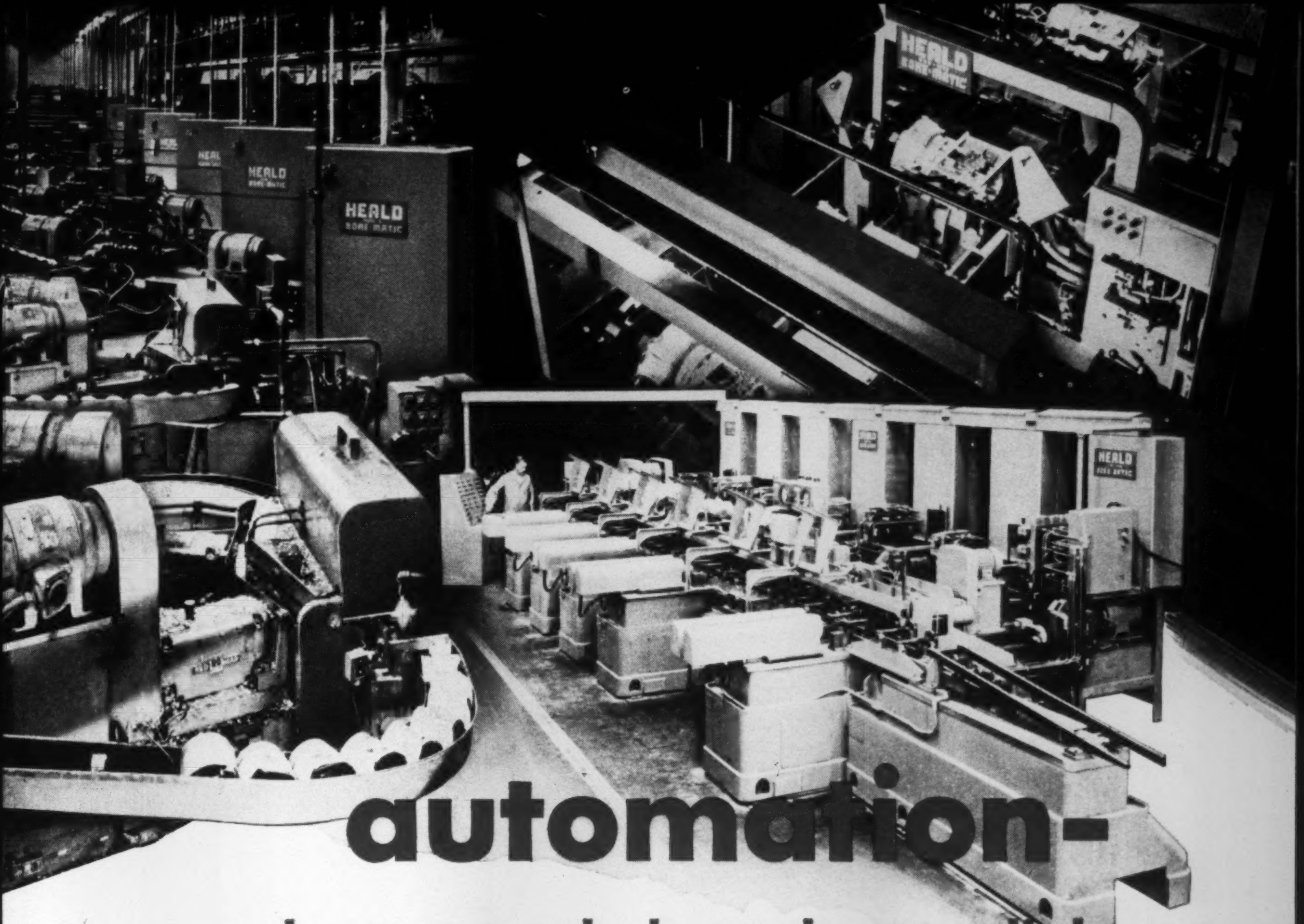


automation-

where so much depends on so little

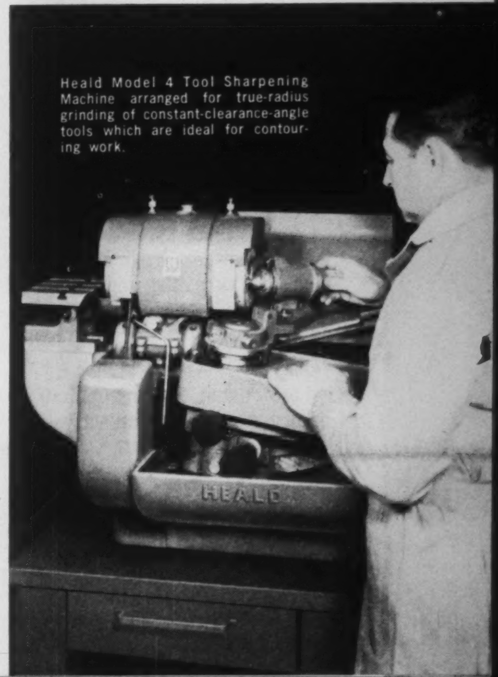
when the tool tip contacts the work

The modern automated production line is a miracle of cost-saving efficiency. But all its ingenious complexity has but one purpose—to bring work and tooling together. *That's* the point where it either pays off or it doesn't.

To assure maximum productivity—hence maximum return on the investment—cutting tools must be sharpened with machine precision. When they are ground on a Heald Model 4 Tool Sharpening Machine, *exact tool geometry* is obtained every time—and cutting edges *last longer,* saving down-time for tool replacement.

This advanced design machine is available for both true-radius and conventional elliptical-point tool grinding. Its fully automatic tool reciprocation assures uniform and repetitive tool tip accuracy and permits one operator to tend several machines at the same time.

Ask your Heald engineer for complete information on the Model 4 Tool Sharpening Machine, or send for Bulletin 2-4-3, Issue 1.


Heald Model 4 Tool Sharpening Machine arranged for true-radius grinding of constant-clearance-angle tools which are ideal for contouring work.

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effective automation begins before the start with COORDINATED CONTROL

Automatic control, the vital element which helps make automation and its many important production benefits possible, involves much more than top quality control equipment. And for most effective automation, automatic control begins long before the start-up—should in fact be the starting point for automation planning.

Today, automation's demanding need for greater effectiveness through continuous, controlled operation, can only be fulfilled by coordinated control—automatic controls designed with a thorough knowledge of, and completely integrated with, all the elements which comprise an automated process, system, or machine.

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That's why today, more and more automation-minded manufacturers everywhere are turning to Clark Controller for completely coordinated control engineering service and equipment.

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APRIL 1960
Vol. 7 — No. 4

AUTOMATION®

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*The Magazine of
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automation outlook

PACKAGING IN THE BIG VIEW

". . . Packaging has become identified in modern management as an all-inclusive process from product development to final delivery and unpacking at the user's plant or the consumer's home. The integration of this broad activity, the clear affirmation of packaging's goals and controls, and the co-ordination of the company's technical and marketing talent into the most effective packaging team possible, all demand the careful scrutiny of successful modern managers. . . ."—*L. A. Appley, president, American Management Association.*

◆

ECONOMICS KEY IN OIL FIELDS

". . . While producing fields today are not highly automated, our engineers tell me that the problem to be solved in automating them is primarily economic rather than technical. The process is not so complex but that it can be accomplished as soon as it is economically feasible. . ."—*A. F. Vinson, vice president and group executive, Apparatus and Industrial Group, General Electric Co.*

MACHINES PLUS CO-OPERATION HOLD PRICES

". . . With inflation a national problem, it is time that coal got some of the credit it deserves. If coal's record was paralleled by other industries, there would be no problem of inflation. Our price at the mine in 1958, for example, was $5.00 a ton; in 1948, it was $4.99 a ton. . . . How did it happen? The answer is simple. Greatly increased productivity. In 1948, the output per miner per day was 6.32 tons. Today it is close to 12 tons per man. A great part of coal's spectacular rise in productivity has been due to mechanization, but it requires skilled and capable men to operate these machines. Nor must we forget that the union and union leaders have encouraged mechanization, even though in some instances workers have been displaced. . . ."—*J. E. Moody, president, Southern Coal Producers' Association and National Coal Policy Conference Inc.*

AUTOMATION AND THE WORK FORCE

". . . the General Motors work force expanded by just under 100,000 jobs since 1948—in the very years that saw "automation" become a scareword signifying "job killer." Along with the growth in the actual number of General Motors employees, there has been an increase in the proportion of higher-rated jobs. . . ."—*L. G. Seaton, vice president-personnel, General Motors Corp.*

BASIC YARDSTICK—PERFORMANCE OF WHOLE

". . . The whole of a system is not necessarily improved if one particular function or part is improved or made more efficient. In fact, the system may well be damaged thereby or even destroyed. In some cases the best way to strengthen the system may be to weaken a part—to make it less precise or less efficient. For what matters in any system is the performance of the whole; this is the result of growth and of dynamic balance, adjustment and integration rather than that of mere technical efficiency. . . ."—*P. F. Drucker, professor, New York University.*

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. . . Fluid Power news

REPORT
NO. 11,103
"ANY-SPEED"
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CUT
EXTRACTION
TIME

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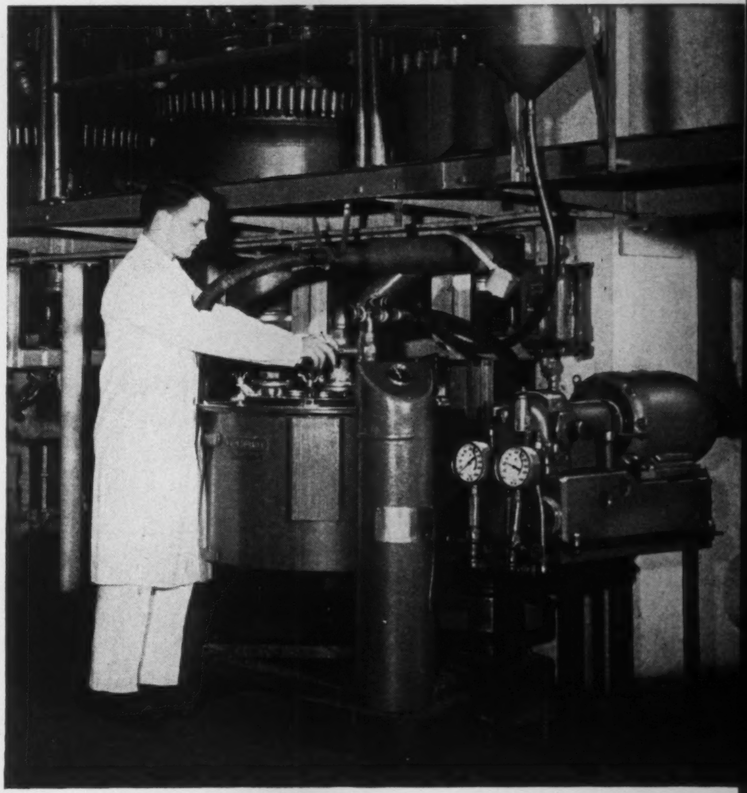

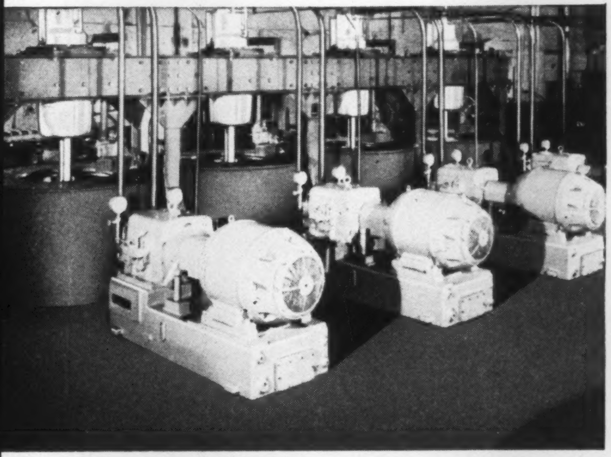

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CINCINNATI GRINDING MACHINE DIVISION

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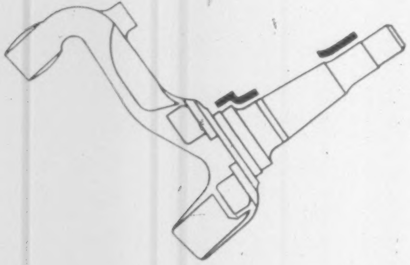
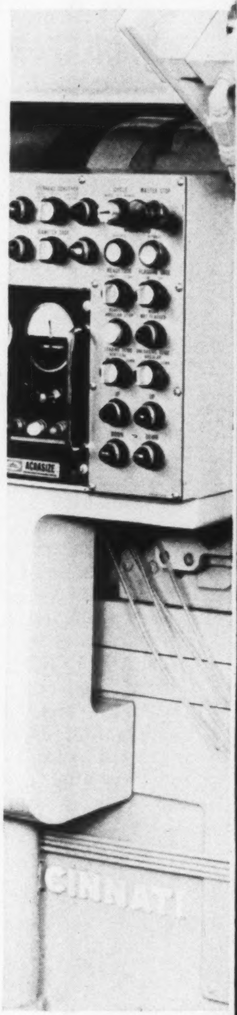




. . . and provides unique advantage of

INTEGRATED BUILDER RESPONSIBILITY

Odd shapes and out-of-balance design create unusual problems for manufacturing engineers. Especially is this true for precision grinding operations, such as those required in the production of steering knuckles. Cincinnati Grinding and Automation Specialists, long experienced in developing equipment to grind unusual parts at unusually attractive production rates, integrated all performance factors to grind three diameters and adjoining faces on steering knuckles at the rate of 80 parts per hour.

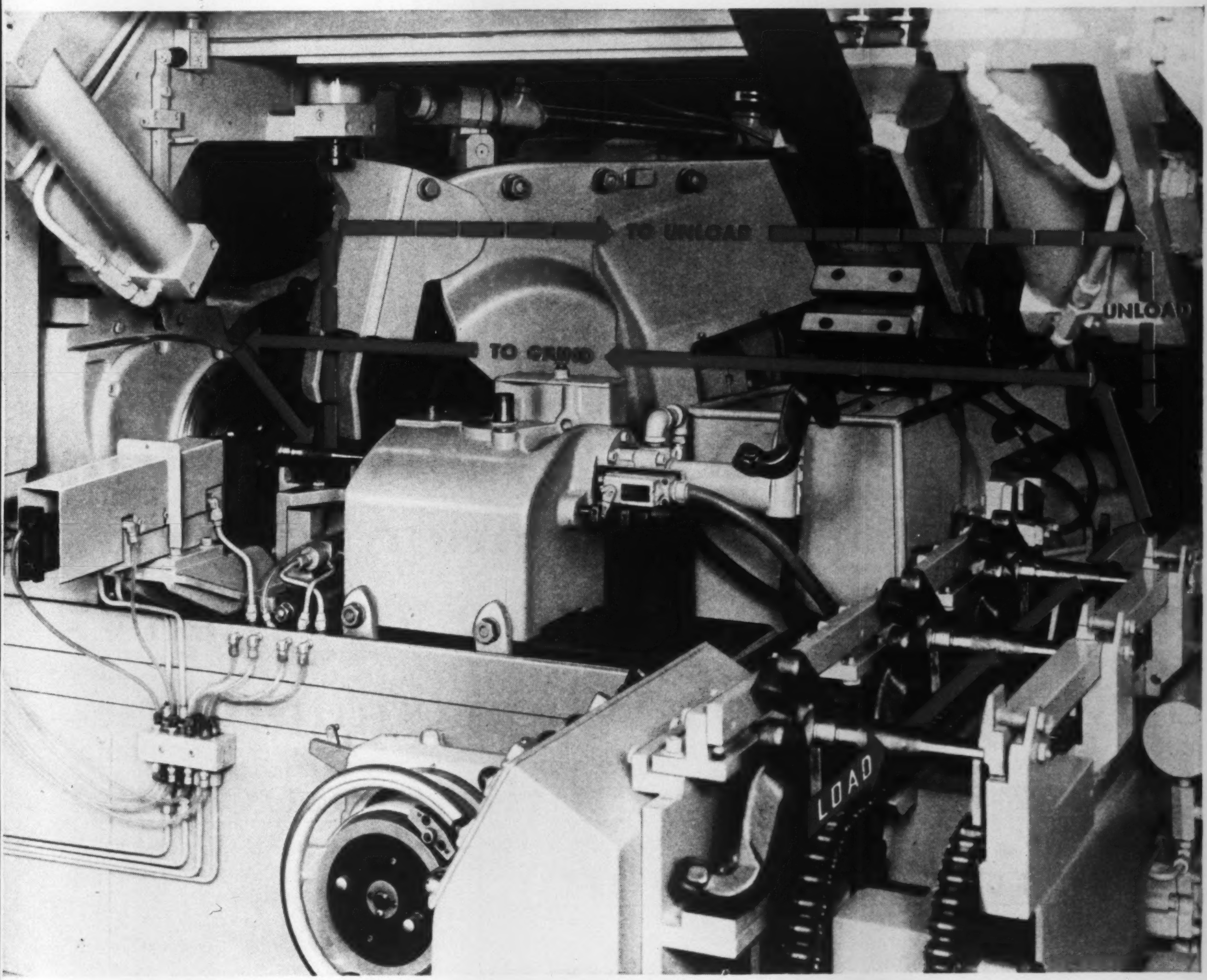
A specially equipped CINCINNATI 14″ L x 18″ Angular Wheel Slide Grinder, illustrated at the right, performs all grinding operations simultaneously. And that's not all. Loading and unloading are automatic, taking the path indicated by the arrows. Cincinnati Acrasize gaging, nerve center of the machine's high precision, incorporates adjustable coarse and fine feed rates for maximum production. The Products Division supplies grinding fluids and correctly graded grinding wheels. The complete equipment package is backed by Cincinnati's extensive facilities for research and development, methods engineering, quality control, experimental grinding.

Only Cincinnati gives you such extensive experience and ability, plus a wide variety of field-tested machines on which to base its recommendations. Our Grinding Machine Specialists will be glad to discuss *your* particular problems. No obligation, of course.

BUILDERS OF PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • MICRO-CENTRIC

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

automates grinding of steering knuckles



STEERING KNUCKLES BOW TO AUTOMATION. A specially equipped CINCINNATI 14″ L x 18″ Angular Wheel Slide Grinding Machine automatically handles the work and grinds three diameters and adjacent faces, at the rate of 80 parts per hour. Interesting features which contribute to this fine performance include:

- Automatic loading
- Automatic flagging
- Automatic dual rate infeed
- Automatic Acrasize gaging
- Automatic compensation
- Automatic diamond wheel truing
- Automatic headstock positioning
- Automatic hydraulic footstock

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CINCINNATI®
GRINDING MACHINE DIVISION

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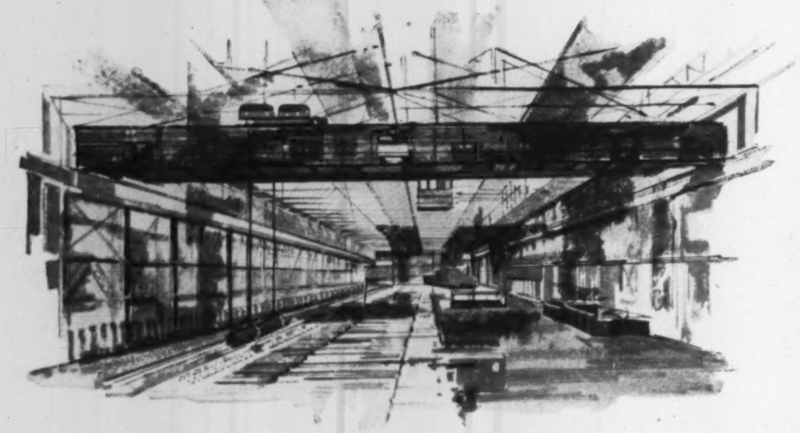

At one of the world's largest integrated steel companies, over 1400 Farval systems unfailingly deliver proper lubrication to each vital bearing on 700 overhead traveling cranes. When equipment is Farvalized . . . maintenance is kept at a minimum.

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FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION

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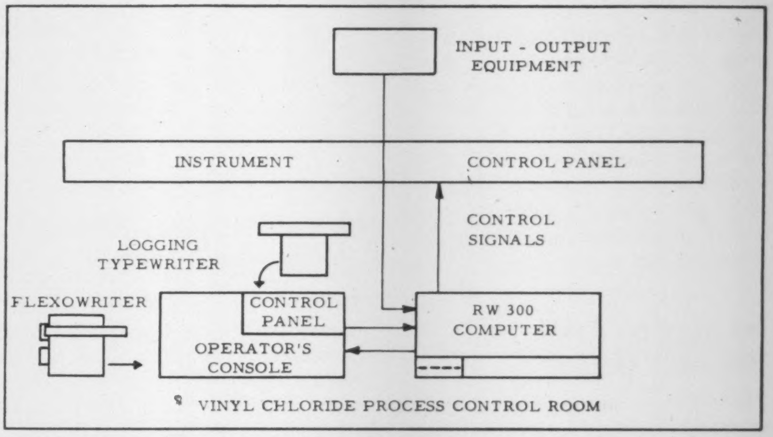
AUTOMATION news

Today's events and developments in the field of automation

Computer Control Applied To Continuous Chemical Process



BLOCK diagram illustrates major elements of computer control system for a vinyl chloride process. System, in use at a plant of B. F. Goodrich Chemical Co., employs a Thompson-Ramo-Wooldridge Products Co. type RW-300 computer. Data scanning, logging, and process control functions are performed automatically by the system.

COMPUTER control of a chemical process is in effect at the Calvert City, Ky., plant of B. F. Goodrich Chemical Co., according to an announcement made recently by **James M. Madigan,** company development scientist. Speaking before a symposium on computer control sponsored by the Chicago Section of the American Institute of Chemical Engineers, Mr. Madigan described the application of a Thompson-Ramo-Wooldridge Products Co. RW-300 computer in the control system for a continuous vinyl chloride process. Functions performed automatically by the system include data scanning, data logging, and adjustment of controller set points in accordance with process needs.

Heart of the system is a master program called an executive routine. Essentially, this is a timed program for all of the duties that the computer performs.

First step in the routine is a test cycle that exercises the computer circuits. Included in the test cycle is a check of the analog-digital and digital-analog equipment. If the system passes this test, the program reads a digital clock and then performs its duties according to the following schedule:

- Every 5 minutes: Scan 128 analog signals from process sensors such as thermocouples, flow and pressure transducers, etc. The signals, which are brought into an input-output unit (see diagram) are converted to digital form and stored in a section of the magnetic drum memory in the computer. An alarm provision causes a Flexowriter to print out in red the numerical values of critical variables that are out of range when scanned.
- Every 20 minutes: Calculate new set points for instrument controllers on the basis of predetermined process goals and the data collected by scanning. This information is also stored in the computer memory in digital form. The computer picks up the information, converts it to analog form, and transmits it to the instrument control panel. There, the analog signals are used to revise the set points of pneumatic controllers in acordance with the calculated new values.
- Every hour: Log process variables. This involves typing out the values of all variables including calculated reactor conversion and stream concentrations. Flows are hourly averages of the 5-minute scans; pressures and temperatures are instantaneous values.
- Every 8 hours: Make process optimization calculation. Objective of this program is to calculate optimum conditions including feed rate and conversion for the pyrolysis reactor. This calculation affects the set point changes commanded by

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For Details, See Pages 13 and 143.

the 20-minute check.

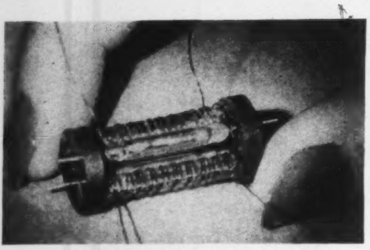
- Every 24 hours: Prepare daily log. A printed record is made of all variables including totalized flows, efficiencies, and new correlation factors.

Special requests may be entered in the system by means of either the Flexowriter or the operator's console. Typical requests are for process or alarm limit changes; a "demand" log of instrument readings taken at the last scan; or a "summary" scan listing the instruments that are out or alarmed.

Success with computer control of the vinyl chloride process has been such that the company plans to adapt the system for automatic control of an acrylonitrile plant at the same location.

Tax Incentive Would Spur Basic Research

CHANGE in tax laws that would encourage industry to provide greater support for basic research was urged recently by **Mark W. Cresap Jr.**, president of Westinghouse Electric Corp. Speaking before the Economic Club of Detroit, Mr. Cresap emphasized the need for expansion of present basic research activities in order to ensure a strong national economy and defense position.



ELECTROMECHANICAL switch developed by Bell Telephone Laboratories, called a "ferreed," combines the high switching speed capability of bistable magnetic material with the relatively high current carrying capacity of metallic contacts. In operation, the magnetic material is switched by application of a current pulse to a coil for as little as 5 microseconds. Resulting magnetic flux closes the contacts of a reed switch. The contacts remain closed until another pulse is received, canceling the magnetic flux.

Mr. Cresap called attention to the Curtis Bill (HR 4797), now before Congress, that would permit a business or individual taxpayer to take an income tax credit—that is, a deduction from the actual tax bill rather than from the taxable income —for contributions to basic research conducted by colleges, universities, and other nonprofit organizations. The deduction would be limited to 90 per cent of the contribution, but could not exceed 5 per cent of the total tax bill.

Under the Bill, a business taxpayer could also take an income tax credit for basic research performed in its own laboratories. The credit, in this case, would be limited to 75 per cent of the amount spent, not to exceed 3 per cent of the company's total tax bill.

Advantages claimed over direct government grants were: Money would go directly from the taxpayer to the user without attrition and added administrative expense, and no conditions would be attached to the grants.

ISA Award To Honor Instrumentation Contributors

ESTABLISHMENT of an annual award to an ISA member making the most important technological contribution to the conception and implementation of a new principle of instrument design, development, or application has been announced by the Instrument Society of America. The award, consisting of a citation and a cash grant of $1000, is to be known as the Arnold O. Beckman Award, named in honor of **Dr. Arnold O. Beckman**, former president of the Society.

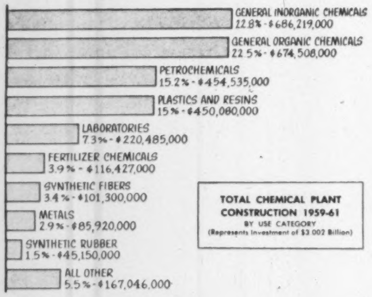
Objectives of the Awards are:

- To stimulate the conception, design, and development of new principles of instrument design, development, and application.
- To acknowledge and reward those individuals who make such contributions to instrumentation technology.
- To honor the contributions and

Survey Points To Chemical Research Facilities Growth

CHEMICAL production and research facilities costing an estimated $3.002 billion will be completed in the United States during the three-year period 1959-61, according to a recent survey by the Manufacturing Chemists' Association. The survey covers facilities used by the chemical industry itself and chemical-producing facilities of firms identified primarily with other industries. Examples of the latter are oil, rubber, and paper companies.

The total expenditure of $3.002 billion represents the construction activities of 318 companies in 42 states. A total of 819 projects is involved, distributed among ten use categories as follows: general organics, 202 projects; general inorganics, 179; plastics and resins, 128; laboratories, 108; petrochemicals, 35; chemical fertilizers, 29; metals, 19; synthetic fibers, 9; synthetic rubber, 8; and miscellaneous, 102. In the latter category fall projects that are confidential or difficult to classify elsewhere.



A breakdown of the survey data according to dollar allocations in each of the ten use categories is shown in the accompanying chart. According to **Gen. John E. Hull** (USA Ret.), MCA president, the increase in research facilities (signified by a figure of $220,485,000 for laboratories as opposed to last year's survey estimate of $157,170,000) is perhaps the most significant development disclosed by this survey. The chemical industry has long been a leader in privately-financed research, and this new construction is expected to create an even broader base of industrial research from which major developments can spring.

Geographically, Texas is the number one state with a total of $792,503,000 for the three survey divisions of Planned Construction, Under Construction, and Completed (1959) Construction. Other states in the top 10 are: Louisiana, $370,905,000; Tennessee, $182,225,000; California, $171,875,000; New Jersey, $128,789,000; Ohio, $114,130,000; West Virginia, $111,545,000; Kentucky, $95,116,000; Michigan, $86,100,000; and Illinois, $83,525,000.

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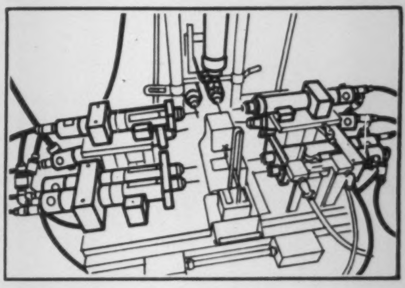
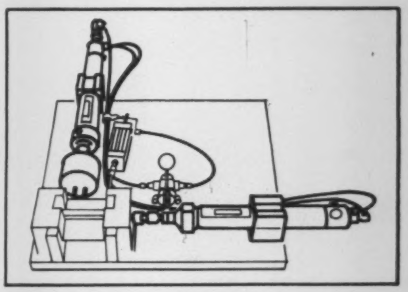
DRILL 3,000 per hour



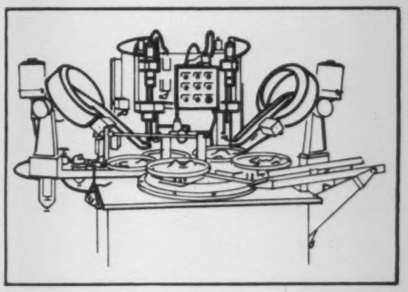
Set up any number of Aro Self-Feed Drills in single fixture, then drill up to 3,000 holes per hour automatically. Capacities from $\frac{1}{16}$" to $\frac{1}{2}$" . . . speeds from 500 to 20,000 rpm . . . stroke lengths from $\frac{3}{8}$" to 6". Use any combination of types and speeds, mount drills in any position.

TAP 2,400 per hour

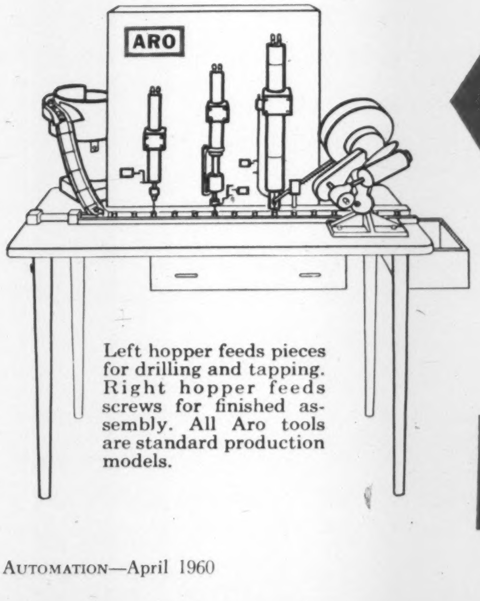


Combine your drilling and tapping operations in one fixture and eliminate costly handling. Aro Self-Feed Tappers have capacities up to $\frac{1}{4}$"-20 in mild steel, or larger holes in softer materials. Speeds of 500, 900, 1,450 and 2,700 rpm. Stroke lengths up to $1\frac{1}{2}$". Accessories for precision depth.

FASTEN 3,000 per hour



Go automatic on your threaded-fastener operations with Aro Self-Feed Screwdrivers-Nutsetters. Standard range of speeds for the most commonly specified screw sizes. Uniform torque settings held within close limits. All models available with precision ball-type clutch.



Left hopper feeds pieces for drilling and tapping. Right hopper feeds screws for finished assembly. All Aro tools are standard production models.

see ARO self-feed air tools *IN ACTION*—drill, tap, fasten!

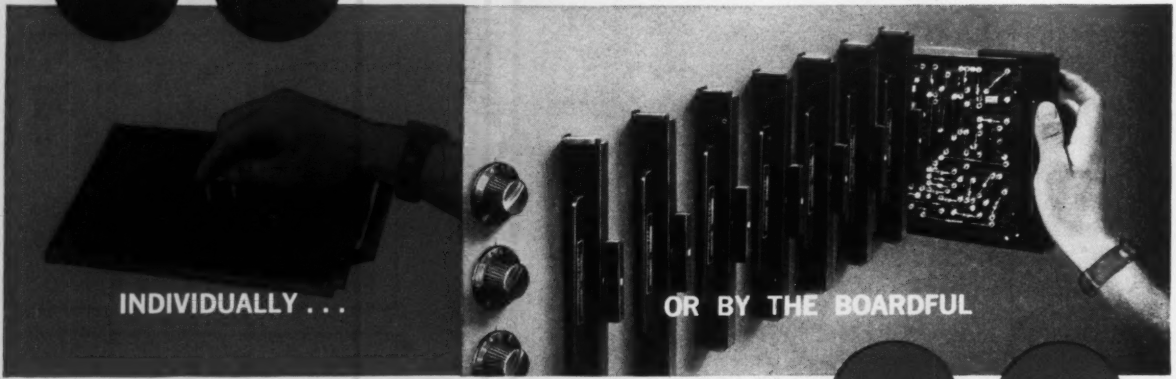
BOOTH No. 1918
A. S. T. E. SHOW

FINISHED SAMPLE IS YOURS!

This top is machined and assembled automatically on fixture at left. It's yours to keep . . . and it's a reminder that *if it's ARO it's tops!*

ARO®

THE ARO EQUIPMENT CORPORATION, Bryan, Ohio
Aro of California, 3141 S. Grand Ave., Los Angeles 7, Calif.
Aro Equipment of Canada Ltd., Rexdale (Toronto), Ontario
Offices in All Principal Cities



“INSTANT COMPONENTS...”

For the first time, here is a component programming device in which the number of inter-chassis connection points is directly related to the chassis area. Without wrenches, soldering irons, or other equipment—you can instantly replace your mounted components, singly or by the hundreds with AMP's all new “816” Pluggable Chassis. These units can be stacked like books on a shelf to save you space and weight and you save also on the number of units and intercircuit connections you use compared to other techniques.

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- Encapsulation—you can pot the entire chassis or lock groups of components into the chassis.
- Reliability—the same high quality construction and performance found in AMP's Patchcord Programming Units.
- Adaptability—other pluggable chassis units are available in a variety of sizes and hole arrangements as required by your specifications.

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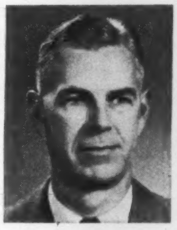
exemplary achievements of Dr. Beckman.

Any ISA member is eligible for an Award, provided he has been a member for not less than one year prior to his nomination. Any ISA member may nominate a candidate.

Nominations for the first Award are now being received at ISA headquarters. The contribution of each nominee must have been described substantially by at least one published paper, patent, or unclassified formal report bearing a date falling

T. R. BUNNELL


K. H. MEYER

C. D. EVANS

H. A. LEONE

C. H. STANDISH

Top Authorities Spark Fourth Manufacturing Automation Conference

W. E. WOOD

E. J. HARDY

R. H. BONNER

H. G. PAYNE

L. E. HARPER

Z. R. SMITH

PANEL SESSION on *Engineering Costs—Who Pays?* (see AUTOMATION—March, 1960, p. 10) will open the 3-day Fourth Conference on Manufacturing Automation that begins on Monday, April 11, 1960, on the campus of Purdue University, Lafayette, Ind. After this initial session, 17 top industry authorities will cover the following additional aspects of automation technology:

T. R. Bunnell—manager, Manufacturing Services, Semiconductor Div., Sylvania Electric Products Inc., will discuss *Manufacturing Research and Automation*. . . . **K. H. Meyer**—manager, Manufacturing Services, Reliance Electric & Engineering Co., will talk on *Getting a Grip on Costs and Payoff*. . . . **C. D. Evans**—ass't. manager, Manufacturing Research, International Harvester Co., will discuss *Organizing to Reduce Costs Through Automation.*

H. A. Leone—manager, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., will cover *Process Analysis and Machine Procurement*. . . . **C. H. Standish**—president, Designers For Industry Inc., will discuss *Automating Assembly,* . . . **W. E. Wood**—president, Processes Research Inc., will talk on *Integrating the Packaging Operation.*

R. H. Bonner—application engineer, Industrial & Machine Tool Operations, Radio Corp. of America, will discuss *Techniques for Parts Handling*. . . . **L. E. Harper**—president, Omega Machine Co. Div., B-I-F Industries Inc., will talk on *Dispensing Problem Materials in Process*. . . . **E. J. Hardy**—ass't. supt., Engineering Equipment Development, Western Electric Co. Inc., will cover *Mechanization for Distribution.*

H. G. Payne—manager, Measurement Group Sales Product Div., Foxboro Co., will discuss selection and application of *Temperature Controls*. . . . **Z. R. Smith**—vice president & tech. director, Potter & Brumfield Div., American Machine & Foundry Co., will talk on *Using Relay Control Effectively*. . . . **J. J. Larew**—product engineer, Specialty Control Dept., General Electric Co., will cover *Doing the Job with Photoelectrics.*

Speaking at the Monday buffet lunch will be **Dr. W. C. Leone,** vice president & gen'l mgr., Rheem Califone Corp., on *Pioneering In Automation;* Tuesday lunch, **R. Moore,** president, Moore Equipment Co., on *Don't Give Up;* Wednesday lunch, **H. A. Strickland Jr.,** vice president & gen'l manager, Industrial Electronics Div., General Electric Co., on *The Inevitability of Automation.*

Monday night Banquet speaker is **Dr. Joseph Harrington Jr.,** head, Mechanical Engineering Section, Arthur D. Little Inc., who will speak on *A Look into Tomorrow.* **F. I. Ellin,** chief production engineer, Ohmite Mfg. Co., is coffee speaker at the Banquet, and will discuss *You and the Manufacturing Engineering Council.*

J. J. LAREW

W. C. LEONE

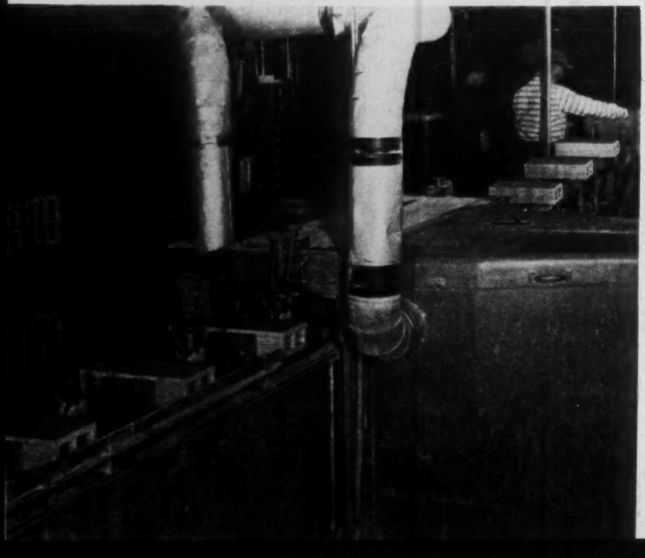
R. MOORE

H. A. STRICKLAND JR.

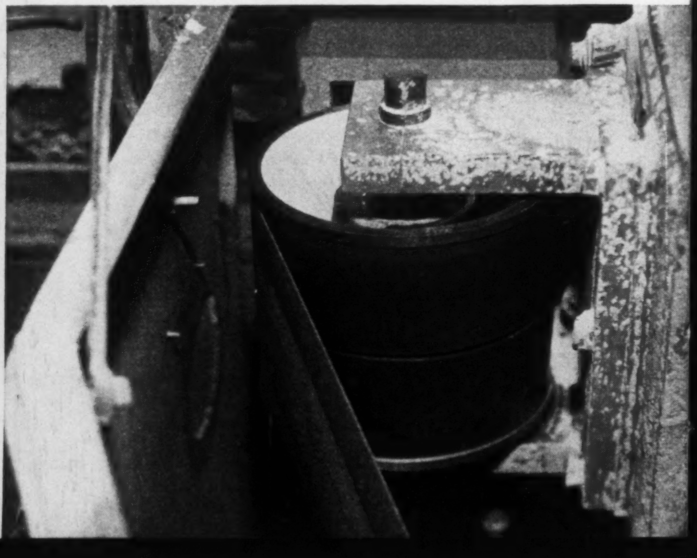
J. HARRINGTON JR.

Tile being ground to a tolerance of $\frac{1}{16}$" in an overall length of 15¾". Two grinding heads staggered in same machine grind two ends in same pass. Due to planned oscillation, belt here is shown in lowest position of the cycle of the up and down movement on roll.

Tile production line showing automatic grinding machine equipped with **LORIG-ALIGNER** self-centering rolls to keep grinding belts perfectly aligned.



LORIG-ALIGNER self-centering rolls have a toeing-in action from both sides that keeps belt centered. Type 1 rolls were used on the sander.



Tile production boosted over 100% with belt grinders using LORIG-ALIGNER self-centering rolls

The Arketex Ceramic Corporation, Brazil, Indiana, produces load-bearing architectural tiles to within $\frac{1}{16}''$ tolerance to the $15\frac{3}{4}''$ overall length. Both ends are ground or sized *before* glazing and firing.

Mr. Ralph Weston, Vice President in charge of production, says, "Originally the production line required hand grinding and delivered 5 to 10 tiles a minute. This was too slow. Next, we installed two emery wheels facing each other across the production line. Output went up to 11 tiles per minute but this was still not enough to satisfy us. In our search for higher efficiency, we called in the Ryman Engineering Company of Pittsburgh, a licensee for LORIG-ALIGNER rolls. They recommended installing two belt grinding machines so that both ends of the tile could be ground automatically at the same time."

In designing the belt grinding machine, Ryman Engineering used LORIG-ALIGNER self-centering rolls to keep the belts in perfect alignment. Production jumped, labor costs were reduced. The savings are obvious.

As a matter of fact, belt alignment was so perfect after installation of the LORIG-ALIGNER rolls that it was possible to install an oscillating feature. In this way, the full grinding face of the belt could be utilized. Arketex was so pleased with the efficiency of this machine that they later so equipped two additional lines. Similar grinding equipment is now under study for other products.

LORIG-ALIGNER self-centering rolls with their built-in centering action also have hundreds of applications in industry where conveyor belts are used or where continuous sheets of material must be kept in positive alignment. Steel or rubber-covered rolls are both designed to supply this action. These are obtainable from licensees for LORIG-ALIGNER self-centering rolls whose names will be supplied on request. For more information, send the coupon.

USS and LORIG-ALIGNER are registered trademarks

United States Steel Corporation — Pittsburgh
Columbia-Geneva Steel — San Francisco
Tennessee Coal & Iron — Fairfield, Alabama
United States Steel Export Company

United States Steel

Circle 661 on Page 19

Mr. Ralph H. Weston, Vice President in charge of production at Arketex, compares rough, unfinished tile (top) with stack of accurately ground tiles.

United States Steel
Room 6063, 525 William Penn Place
Pittsburgh 30, Pa.

Please send your booklet, "LORIG-ALIGNER Self-Centering Rolls," to:

Name____________________

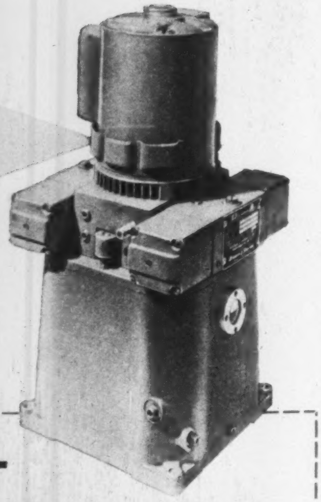
Title____________________

Company____________________

Address____________________

City__________ **Zone**____ **State**______

(Please Print)



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Low-cost hydraulic power! The CircuitPak prices hydraulic power competitively with air power, for clamping, indexing, pressing, drilling, welding, etc. Get the precise control and pressures you need, with CircuitPak.

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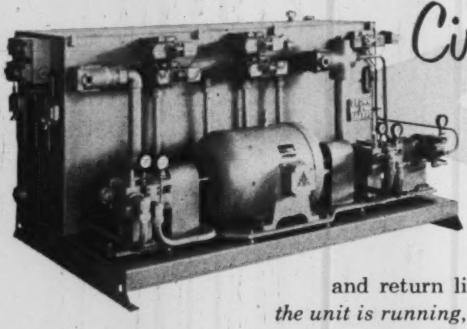
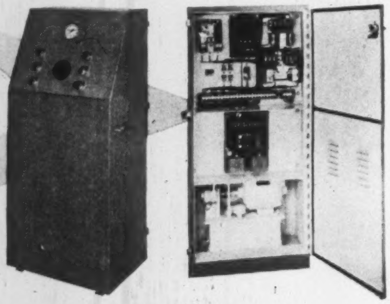


CircuitMaster

The unique L-shaped CircuitMaster design cuts external piping 40% or more, eliminates separate panels and manifolds. Every component is easily reached. Fluid from individual drain and return lines may be observed *while the unit is running,* for faster trouble-shooting.



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Double A builds complete hydraulic-power and electric-control packages, providing one-stop shopping for the equipment builder.

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Circle 662 on Page 19

MMT=PE

NOW it can be told. The letters *MMT=PE* in this emblem signify the slogan for The Machine Tool Exposition—1960, which is: Modern Machine Tools = Production Efficiency. Seen in magazine ads, on some business letterheads, and in the form of lapel and tie pins worn by machine tool salesmen and engineers, the emblem is intended to promote interest in the 11-day Exposition to be held in Chicago next Sept. 6-16. The sponsor, National Machine Tool Builders' Association, is making special arrangements to accommodate an expected 125,000 attendees who will see more than 1000 machine tools displayed by over 130 builders.

within the two-year period ending October 31, 1959.

The Society's Instrumentation Committee will judge contributions on scientific originality, usefulness of the contribution, and execution of the principle involved. Citation and grant for the first Award will be made at the ISA annual meeting in New York this September.

ASTME Show Features Broad Technical Scope

HIGHLIGHT of the 1960 ASTME Engineering Conference and Exhibit to be held in Detroit, April 21-28, will be the technical sessions conducted at the Sheraton-Cadillac Hotel. During the eight-day event, sponsored by the American Society of Tool and Manufacturing Engineers, more than 70 technical papers will be presented or discussed.

Of particular interest to manufacturing engineering and management people will be a three-part symposium on *Automation and Numerical Control* to take place on April 26. **James C. Keebler,** managing editor of AUTOMATION, will set the stage for this event with an introductory paper. Other speakers at the symposium will be: **William C. Goeckel,** sales manager, Snyder Corp., who will discuss "Areas in Which Automation is Useful"; **Wallace E. Brainard,** chief engineer, Servo Machine Tool Div., Kearney & Trecker Corp., who will speak on "A Hole in the Tape is Worth Two in the Head"; **Robert B. Read,** service manager, Cross Co., who

around the triangle

PRODUCTION LINE SETUP SPEEDS MISSILE WELDING

Speedup of a high precision welding operation has been accomplished with two company designed gantry welders at the Sheffield, Ala., missile plant of Reynolds Metals Co. The gantries replace a single stationary unit and permit operations at as many as 10 working positions. Riding on 180-foot long rails, the gantries can be positioned over multiple sets of friction rolls used to rotate large aluminum shells for Redstone missiles. Equipment carried by the gantries is capable of girth welding the shells in pairs. Each set of friction rolls is 8-feet long and can be driven independently so that with a gantry over one pair of shells, setup operations can be carried out on other roll sets. Roll rotation and operation of the metal inert gas welding equipment is controlled from a console on each gantry.

SEE-THROUGH CONTAINERS REPLACE PAPER CARTONS

Dealer replacement items such as nuts, bolts, and small automotive parts are now packaged in transparent plastic boxes at Buick Motor Div., General Motors Corp. Equipment for forming containers from butyrate or acetate films, inserting parts, and sealing filled containers with adhesive coated paper in one continuous operation was developed by company packaging engineers. Addition of an antioxidant to the adhesive provides corrosion protection to the parts, which may be inserted in any of six sizes of containers.

NEW LOOK IN ELECTRIC MOTORS

An electric motor for servo and instrument use, employing a flat printed circuit instead of the conventional wire-wound armature, is now available in production quantities from Photocircuits Corp. The printed circuit motor (see AUTOMATION—May 1959, p. 10), is expected to enable considerable improvement in the performance of instrumentation, controls, electronic equipment, business machines, and home appliances. Smooth torque at low speeds, coupled with extremely low armature inertia, allow printed circuit motors to be used for direct drive in servo applications without costly gear trains. Another feature of the new motors is low armature inductance that reduces the sparking normally associated with commutating.

DRY FILM LUBRICANT EASY TO APPLY

A bonded film lubricant developed by Poly Chem requires no extensive pretreatment of part surfaces to obtain mechanical anchoring of the film to the parts. Normally, only the removal of grease and loose scale are required. Applied by spraying, brushing, or dipping, the lubricant clings to smooth metal surfaces with molecular attraction. Adhesion is provided by a resin binder, while low friction results from use of molybdenum disulfide pigment in the formulation. The bonded dry film lubricant is useful where parts requiring lubrication are inaccessible or maintenance is neglected; where contamination and dust pickup must be avoided; and for high temperature and pressure applications.

SPEED METER WORKS THROUGH AIR GAP

No mechanical connection is required for a speed indicating device developed by Westinghouse Electric Corp. A pickup probe, located near a gear or notched shaft, generates a pulse each time a tooth or notch passes the probe. Pulses from the pickup probe are fed to a static circuit that converts the pulses to a dc millivolt signal. The magnitude of this signal is proportional to pulse frequency and hence, rpm of the shaft. A meter connected to the static circuit can be calibrated to read rpm directly. Applications for the device include use as a tachometer, frequency meter, or rate meter.

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AUTOMATION

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AUTOMATION **April, 1960**

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405	445	485	525	565	605	645	685	725	765	805
406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
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424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	769	799	839
440	480	520	560	600	640	680	720	760	800	840

AUTOMATION **April, 1960**

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423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
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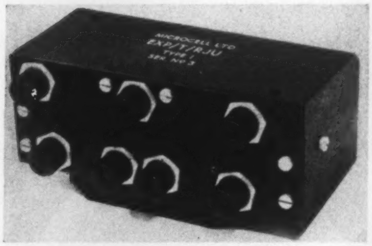
will cover "Field Experiences with Automation"; **Charles E. Chapman,** manufacturing engineer, Flight Propulsion Div., General Electric Co., who will discuss "Numerical Controls—How We Use Them"; and **Carl F. Stugard,** vice president and manager, Special Machine Div., Cincinnati Milling and Grinding Machines Inc., who will talk on "What is the Future of Automation and Numerical Control?".

Other technical sessions will be devoted to topics such as dimensional metrology, engineering education, standardization and machine design, value analysis, production programming, explosive forming, and electron beam processing. A "Techtour" on gun drilling has been scheduled in which papers will be delivered in the morning, followed by an afternoon plant tour that ties in with the subject. Accompanying $15 million Tool Show will contain industrial exhibits.

Airline Reservation System Provides Extended Services

ELECTRONIC airline reservation system, designed by International Telephone and Telegraph Corp., caters to each passenger's individual requirements to the extent of recording his dietary preference, automobile reservations, original and alternate itinerary, and such routine data as the passenger's seat assignment, address, and telephone number.

In operation, details concerning available seats, reserved seats, and the waiting list in each class, on 9000 Air France flights scheduled six months in advance, are stored in six memory drums. Reading and



ELECTRONIC SWITCH developed by Microcell Ltd., London, England, sequentially unlatches multiple electromechanical locks by switching a current pulse of 5 amperes from lock to lock. If a lock sticks, safety devices are actuated and the sequence continues. Transistorized unit measures only 4 by 2½ by 1½ inches.

NEW SWANSON-ERIE
DOUBLE TOOL PLATE*
Turret Indexing Machine Chassis

Offers You
- Tool and Fixture Accessibility
- Tool Standardization
- Reduced Jam Potential
- Positive Parts Control

*Patent Pending

This new double tool plate indexing machine chassis represents a fresh approach to automatic assembly and processing. Tooling is center mounted on the lower tool plate . . . actuation is provided by the upper tool plate. A cam shaft extension is also available for supplementary tool actuation.

The new design represents an important advance in the SWANSON INTEGRATED CONCEPT that incorporates all necessary facilities for *work transfer, tool mounting* and *tool actuation* in a standard chassis that is built to give you . . .

better automatic machines for less cost in less time

Write for Details . . . without obligation

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SEC
802 EAST 8th STREET
ERIE, PENNSYLVANIA

Designers and Builders of Automatic Assembly and Processing Machines.

Circle 663 on Page 19

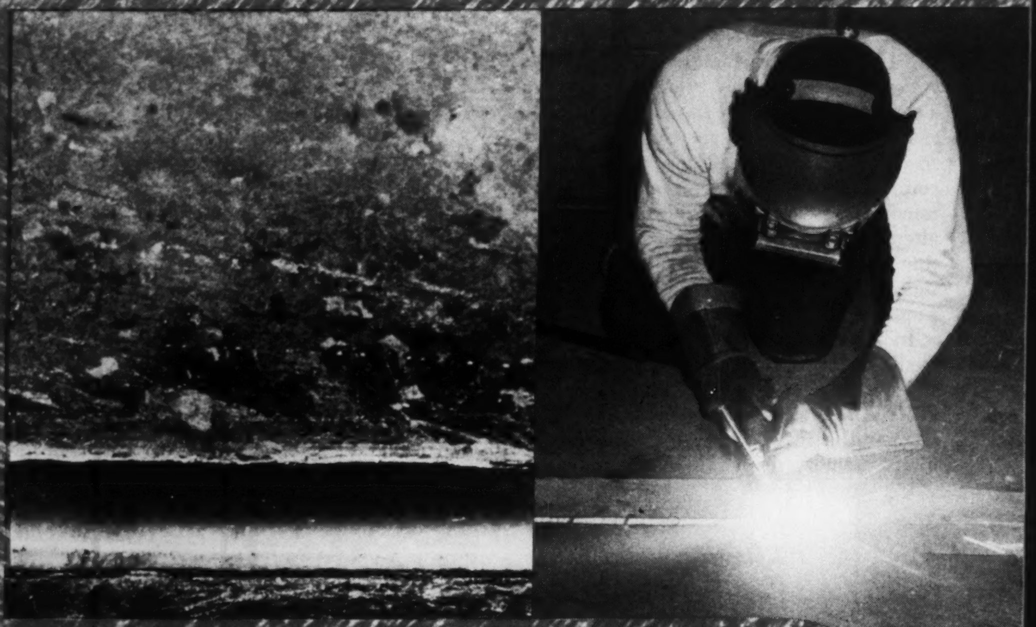
new Westinghouse WS silicon welder...

Arc-air gouging for metal removal offers an outstanding path to cost reduction. The new Westinghouse WS welder has been designed as the ideal companion to this process.

Weld or gouge—be SURE you do it with the 500-amp WS because, in addition to the natural advantages of a hermetically sealed, high capacity, silicon diode rectifier, it affords threefold protection.

Three automatic protection features eliminate the need for special precautions by the operator. First: an exclusive surge suppressor circuit to protect against transient voltage spikes. Second: an integral transformer thermal switch that prevents overheating with prolonged use. Third: an exclusive time and current sensing

(Below) The gouge and the gouging.



designed specifically for arc-air gouging, too!

relay circuit that prevents damage from the above normal current or above normal duty cycle.

You benefit with greater production and fewer repair bills. What's more, you have a dual-purpose unit that can both weld and arc-air gouge, a welder you can count on to work whenever you need it.

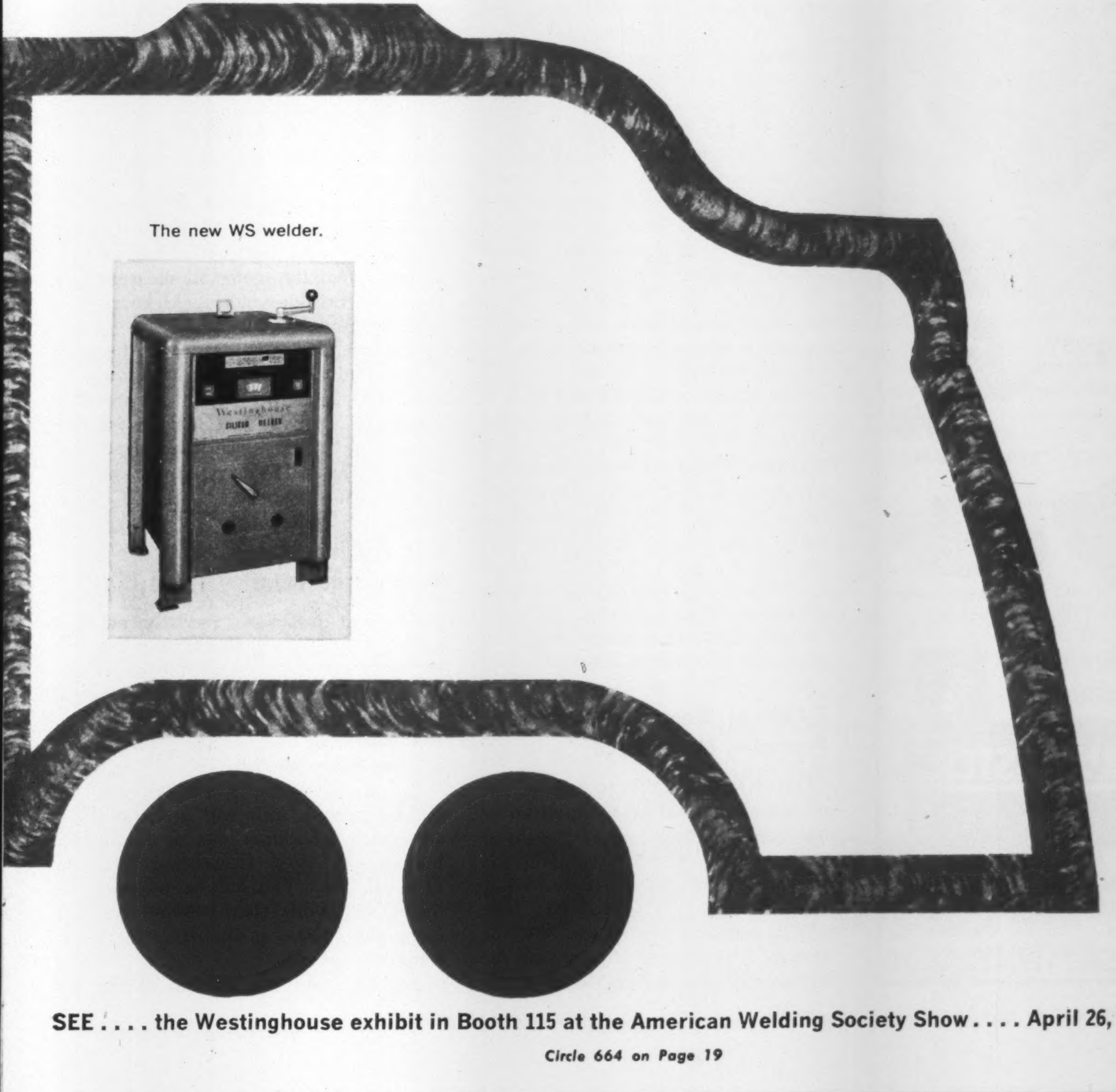
You can get other Westinghouse WS units with the same ruggedness and reliability. Capacities: 200, 300, 400 as well as 500 amps for 230/460-volt a-c operation.

Want more information on the industry's newest, most versatile welder? Contact your nearest Westinghouse Welding Distributor . . . or write Westinghouse Welding Division, 4454 Genesee Street, Buffalo 5, New York.

J-10483

watch Westinghouse for new developments in welding!

YOU CAN BE **SURE**...IF IT'S Westinghouse



The new WS welder.

SEE . . . . the Westinghouse exhibit in Booth 115 at the American Welding Society Show . . . . April 26, 27 and 28.

Circle 664 on Page 19

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"L" SERIES

A HIGH QUALITY LINE OF MALLEABLE HOUSED BEARING UNITS AND BEARINGS AT A COST THAT IS WARRANTED ON YOUR MACHINE!

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Available in pillow blocks and two or three bolt flange units for flush or recessed mounting. All units in the "L" Series available with the new SEALMASTER contact type seal.

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LF FLANGE UNIT

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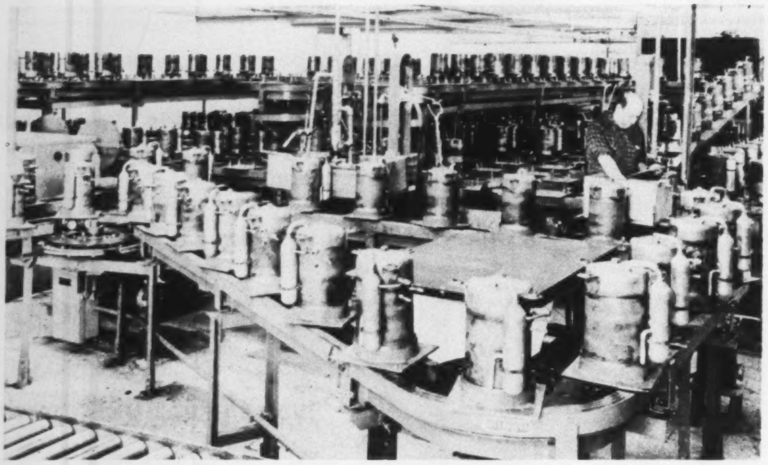

STANDARD overhead-type conveyor, operated upside down, forms this system for moving products through an assembly area at worktable height. Pallets are mounted on four-wheel trolleys that are pulled by cable. Suitable for products such as gears and high voltage insulators, conveyor was developed by E. W. Buschman Co.

writing heads constantly scan the 300 tracks of each drum, interpreting the information which passes under them. Other information, such as a passenger's name and address, is read from one of 60 magnetic tapes contained in six racks.

The information entering and leaving the memory drums and tapes passes through a third series of memories which employ ferrite memory components. These memories receive the information from the tape and drums and transfer it to logic and arithmetic circuits for readout processing.

The system was developed by two I. T. & T. affiliates in Europe: Le Materiel Telephonique, Paris, and Standard Elektrik-Lorenz, Stuttgart, Germany. It will enable 500 airline clerks to reply in less than five seconds to any request for information concerning any passenger from among several hundred thousand registered. The computer can also automatically receive and reply to telegrams of uniform format.

Technical Manual Describes Proximity Meter Gage

COMPREHENSIVE technical applications manual on a capacitance-operated proximity meter has been published by Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co. The booklet, TM-951-2, contains a complete description of the device, circuit and dimensional information, and application specifics including layout and configuration details.

Applications outlined in the booklet include use as a micrometer without application of pressure and without physical connection to the work, a concentricity gage without physical contact, a surface finish gage, a strain gage, and for measurement of surface finish internally. Other uses involve utilization of the proximity meter to measure vibration, breaking strain, thickness, pressure, and moisture content.

Performance and adjustment figures contained in the manual provide sufficient information to permit application of the device for measurement of physical displacement, dielectric constant, or cyclic motion.

Gas Turbine Engines To Undergo Industry Trials

TWO test programs recently announced by General Electric Co. are intended to substantiate the technical and economic feasibility of using small gas turbine engines in oil well fracturing and natural gas pipeline pumping operations.

In one program, a 1200-pound, 900-horsepower unit will undergo a six-month laboratory test at Halliburton Oil Well Cementing Co., Duncan, Tex. This will be followed by a six-month field service test using the engine as the drive for a fracturing pump.

For the field test portion of the

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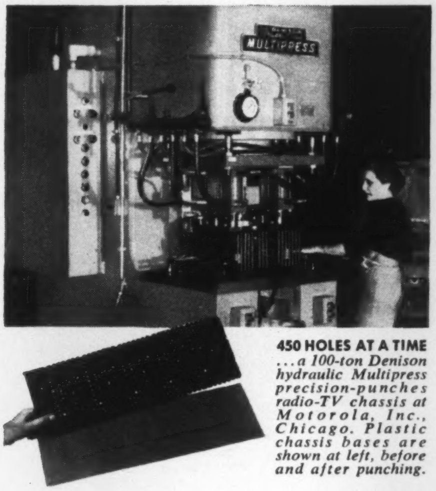
NO SCRAP



450 HOLES AT A TIME *. . . a 100-ton Denison hydraulic Multipress precision-punches radio-TV chassis at Motorola, Inc., Chicago. Plastic chassis bases are shown at left, before and after punching.*

NO SCRAP problems on this pressing job. And Motorola radio-TV plated-circuit plastic chassis bases produced at this Chicago plant are precision-punched faster . . . more accurately . . . at less cost with Denison hydraulic Multipress.

Here's why: With one quick ram stroke, a 100-ton Multipress punches up to 450 holes at a time in each base. Multipress does the job with *no shock* . . . with absolute control after break-through. Holes are clean and smooth . . . affording the necessary, uniform plating surface inside each hole. There's *no bulging . . . no cracking* around or between holes because Multipress delivers controlled hydraulic pressure.

Plus benefits with Multipress—longer die life . . . almost no punch breakage . . . handles 15 different dies for quick changeover to other full-production jobs . . . *and there's almost no scrap loss.*

Endless jobs throughout the electronic and other industries can be done better . . . for less with Denison hydraulic Multipress—capacities from 1 to 100 tons. Ask your Denison Production Specialist to show you how with a **M**ultipress **A**nalysis **P**rogram made in your plant now—at no cost. It's the first step to **MAP** new savings in your production operations.

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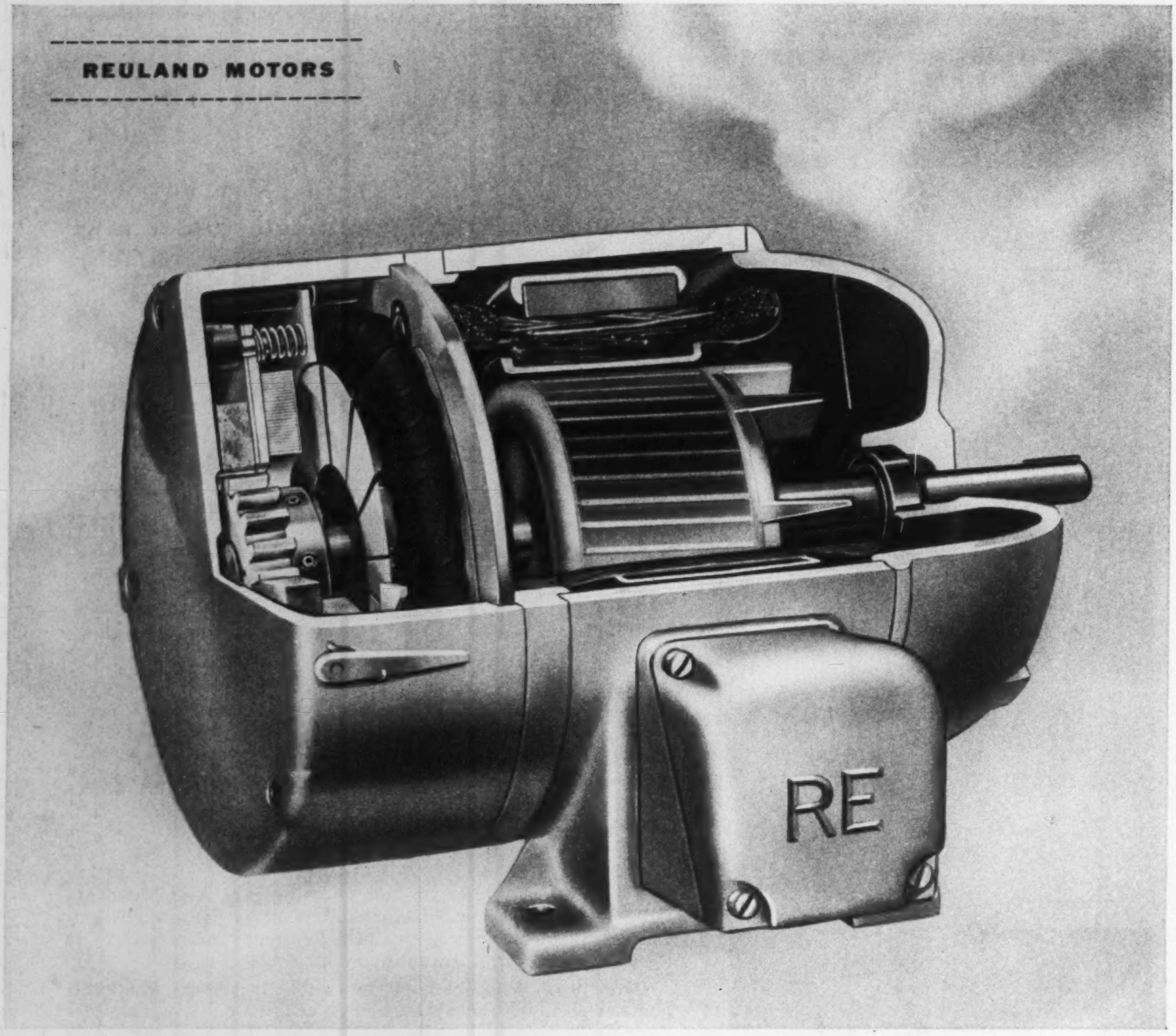

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... complete from one dependable source!

Reuland manufactures its own magnetic brakes, as well as electric motors, and offers the most versatile selection of tailored-to-your-equipment *brakemotor* packages available anywhere. Reuland's many hundreds of combinations of H.P., speed, special drive motors and brake sizes, provide an almost unlimited coverage of O.E.M. and user requirements!

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Refer to Sweet's Product Design, Section 5-a

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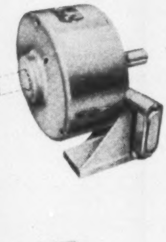

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- Mount in any position
- No Levers or Linkage
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- One-Half Conventional Length
- Wide Range of Ratings

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program, a liquid fuel burning engine will be mounted on a truck. It will power a pump delivering up to 1100 gpm at pressures up to 8000 psi, handling an oil and sand slurry.

The second program will involve use of a natural gas burning engine for one year at a main-line natural gas pumping station of the Trunkline Gas Co., Houston, Tex. The engine will be used to drive a double-shaft, centrifugal gas compressor.

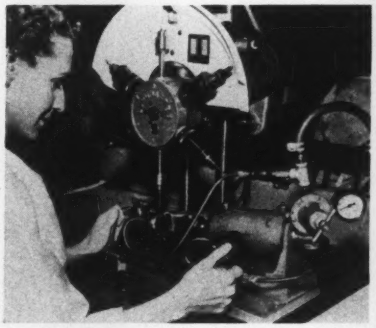
Advantages claimed for the gas turbine engine are light weight, small size, no warm-up period to develop full power, and no necessity for a cooling run at the end of a working cycle.

The two test programs represent the first applications of the G. E. gas turbine engine in the oil and natural gas industries, according to company officials. Presently, the engines are used in several military marine and helicopter applications.

Load Control System Programs Line Equipment

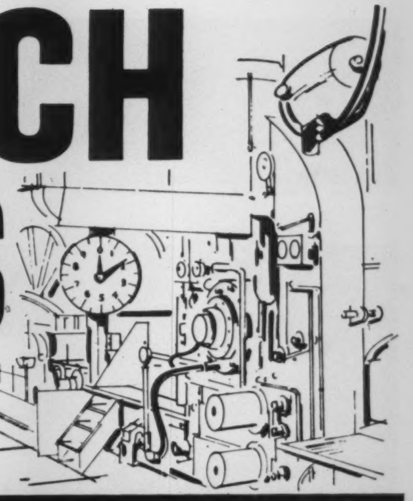
AUTOMATIC load control system installed in the Ford Motor Co. Buffalo Stamping Plant is designed to eliminate excessive voltage drop problems. The system is being used on a line of 50 resistance welders in a part of the plant.

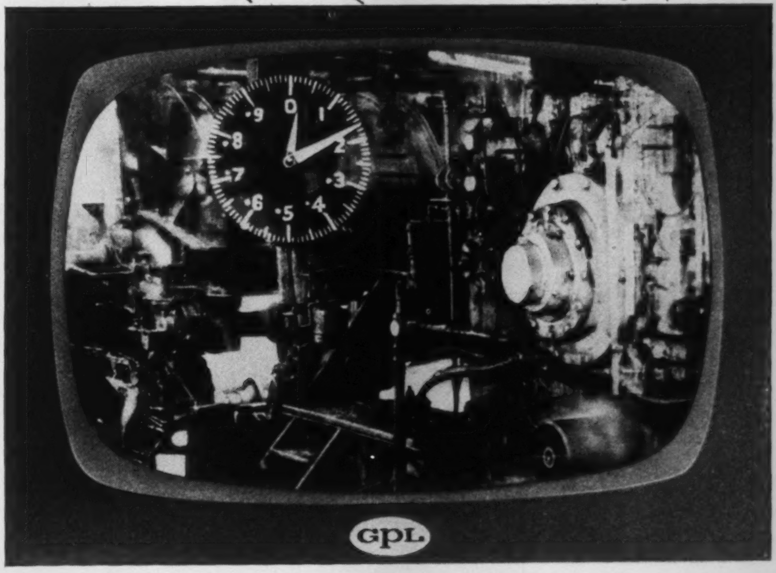
In effect, the automatic welder load control, developed by Instrument Control Co., continuously



ASSEMBLING and machining operations are combined in this setup for producing dial potentiometers. In operation, a dial and knob are clamped in an air-operated fixture. A Burgmaster Corp. drilling machine is actuated to drill and tap a hole, and then assemble a socket setscrew in the tapped hole. The six-spindle turret of the drilling machine is double-tooled; that is, each of the three operations is performed twice for one revolution of the turret. Hex wrenches used to drive the setscrews are chucked in tapping heads that have adjustable torque.

WATCH THIS





Keeping an Eye on Gauge and Rollers at a Reversing Mill

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How Many Jobs

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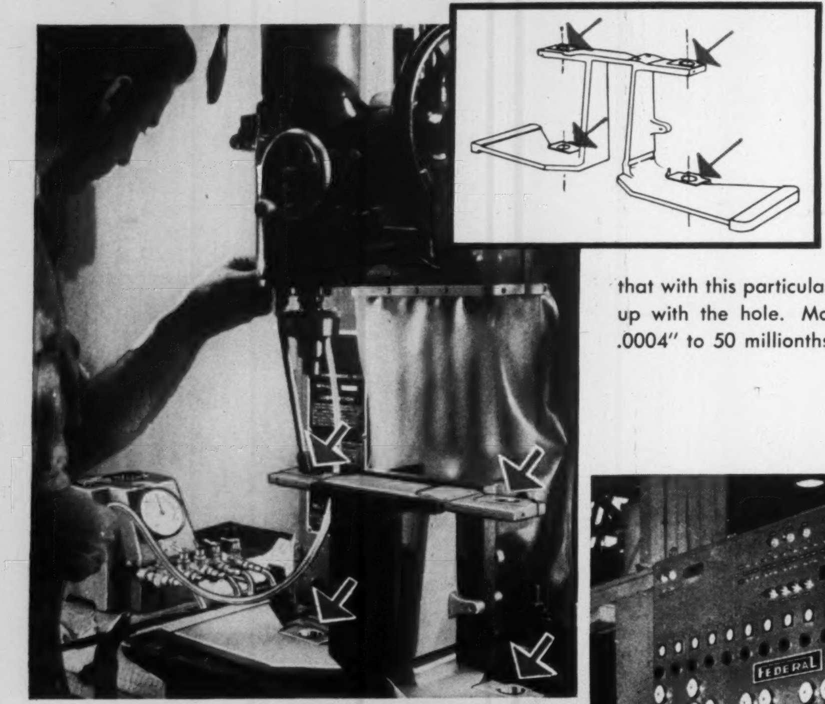
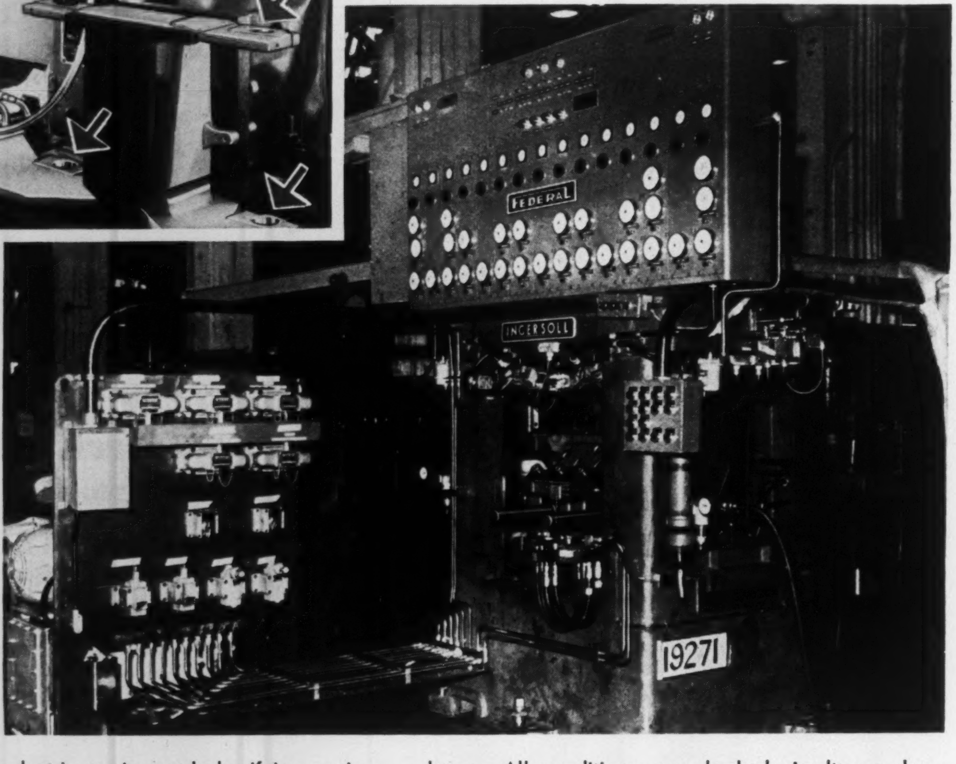
THEY GAGE THESE



This application at the Arrow Tool Company, Inc., illustrates the adaptability of the Dimensionair. Here it is equipped with a 5-way manifold to which different gaging units are attached ready for other jobs. On this job a Model A-1250 Adjustable Bore Gage is used to inspect 4 holes. Note that with this particular gage the handle does not have to line up with the hole. Many other jobs, having tolerances from .0004" to 50 millionths, are inspected by this Dimensionair.



Federal air-electric gaging and classifying equipment was used in this gaging station on an engine block transfer line. Two diameters in each of five crankshaft bores and two each in five camshaft bores are measured — twenty holes in all. After automatic assembly, oil holes in the five bearing liners are checked for alignment with the holes in the camshaft bores. All conditions are checked simultaneously. Signal lights indicate all dimensional conditions. Unsatisfactory blocks are automatically rejected. Cycle time is well within production cycle time. Ingersoll Milling Machine Company supplied the handling and positioning units.

JOBS BETTER

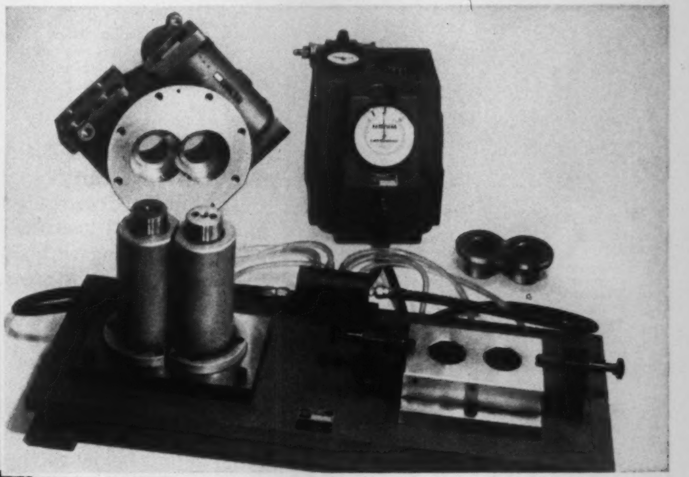
*'60 BOOTH 1000

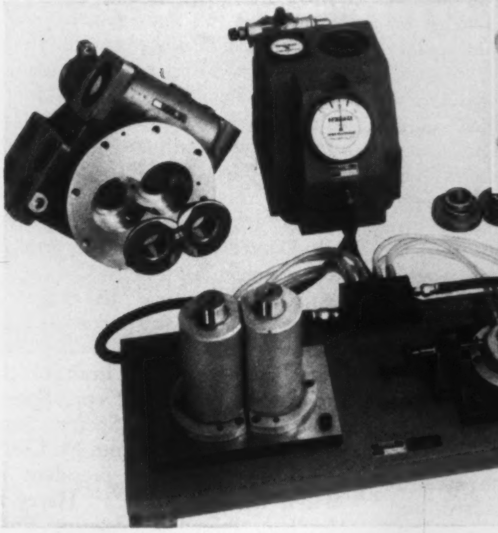
with the DIMENSIONAIR

The increased complexity of more and more of today's gaging requirements calls for the utmost in dependable accuracy. So many times the accuracy of one dimension is dependent upon the accuracy of another. Automation, too, brings in another set of complications where misbehavior of the gaging process can upset your whole schedule.

The dependable no-drift accuracy of the Dimensionair is of the utmost advantage in such cases. Its reliability keeps quality up and keeps production rolling. Even on the simpler jobs the dependable no-drift accuracy and the foolproof operation of the Dimensionair are definitely appreciated. Call on us if you want to do a better gaging job. See our address below.

Two differential type Dimensionairs are used on this precision assembly. The first step is shown at right. Parallel bores in a gear-type fuel pump housing are located on the twin gaging plugs and the bushings that are to be pressed into these bores are placed in the twin ring gage at the right. The Dimensionair shows whether the flange flats on the bushings will have the proper clearance when bushings are assembled in the housing.





A second gage is used for the next step. After the bushings are inserted in the housing, they are located on the left hand pair of gage plugs. Then, a different set of bushings for the cover plate is placed on the right hand plugs. The single dial on this gage shows whether the center distances in the two pairs of bushings are the same within a tolerance of ±.0005". If the first two cover plate bushings measured do not meet this standard, others can be tried until a pair is found that does. Proper alignment of these bearing surfaces is assured at final assembly.

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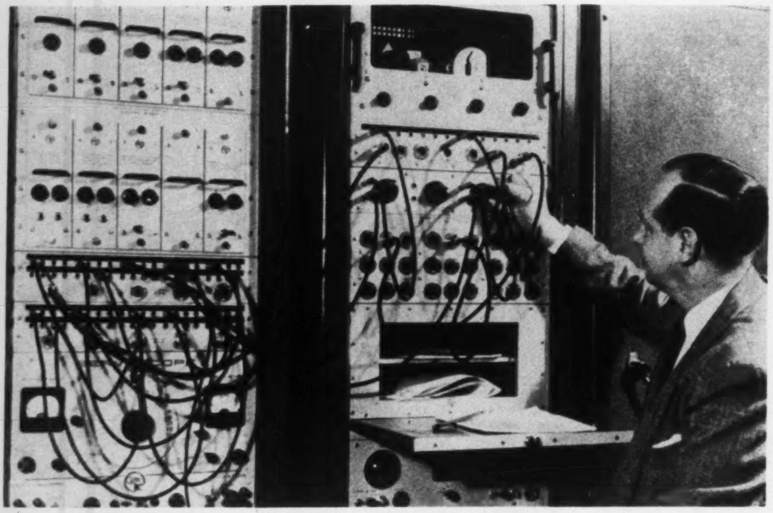
FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

Circle 669 on Page 19



SERVO system simulator developed by Servo Corp. of America reproduces the dynamic characteristics of actual systems or subsystems such as those used in the control of machine tools and continuous processes. Versatile synthesis and analysis unit, designated Servolab, can be used as a design tool, a prototype debugging device, a production checkout system, and an on-the-job training aid. Programming is by means of patching cords that interconnect appropriate modules.

monitors the line to determine how much load it is carrying, how much voltage drop is occurring, and how much additional load the line is capable of handling without dropping the voltage below a preset value.

At any time when a welder is ready to weld and wants to come onto the line, a determination is made as to whether that welder's load can be added to the load being carried on the line, without dropping voltage below the preset value. If the answer is "yes", the welder fires. If the answer is "no", the welder waits momentarily until a firing welder somewhere else on the line completes its firing and drops off. In many cases there is no waiting at all, and the welder will fire as soon as it is ready.

Ford plant officials report that their voltage drop is now being held to a minimum (6 per cent). This figure is well within the area in which good welding is assured, and no reduction in speed of production is experienced with the controls.

SPOTLIGHTING PEOPLE

James E. Heath named director of manufacturing for the Mechanical Div., General Mills Inc. . . . **Lester V. S. Sanson** appointed manager of manufacturing and parts service division of the Ground Systems Group, Hughes Aircraft Co. . . . **Malcolm C. McWeeney** named manager, Data Processing Systems Operation, Electronic Data Processing Div.; and **R. V. Miraldi** appointed manager of management engineering, Defense Electronic Products, Radio Corp. of America. . . . **C. Bruce MacKenzie** named manager of research and engineering information at International Business Machines Corp. . . . **Robert E. Place** named chief estimator, **Joseph Brown** appointed chief engineer, and **Daniel Smith** named production manager for Planet Corp. . . . **Louis Polk Jr.** appointed manager of operations of various product divisions at Sheffield Corp. . . . **Seymour Weiner** named head of the Product Engineering Dept., Sperry Semiconductor Div., Sperry Rand Corp. . . . **Lt. Gen. James M. Gavin** (USA Ret.) elected president of Arthur D. Little Inc. . . . **Harry A. Sandberg** joined Rosemount Engineering Co. as head of manufacturing. . . . **Roy E. Woenne** named director of manufacturing of Electron Tube Div., Litton Industries. . . . **Robert R. Reisinger** joined Telex Inc. as mechanical design supervisor in the Systems and Special Products Div. . . . **C. E. Hitch** appointed manufacturing manager, and **Orval A. Opperthauser** named chief engineer

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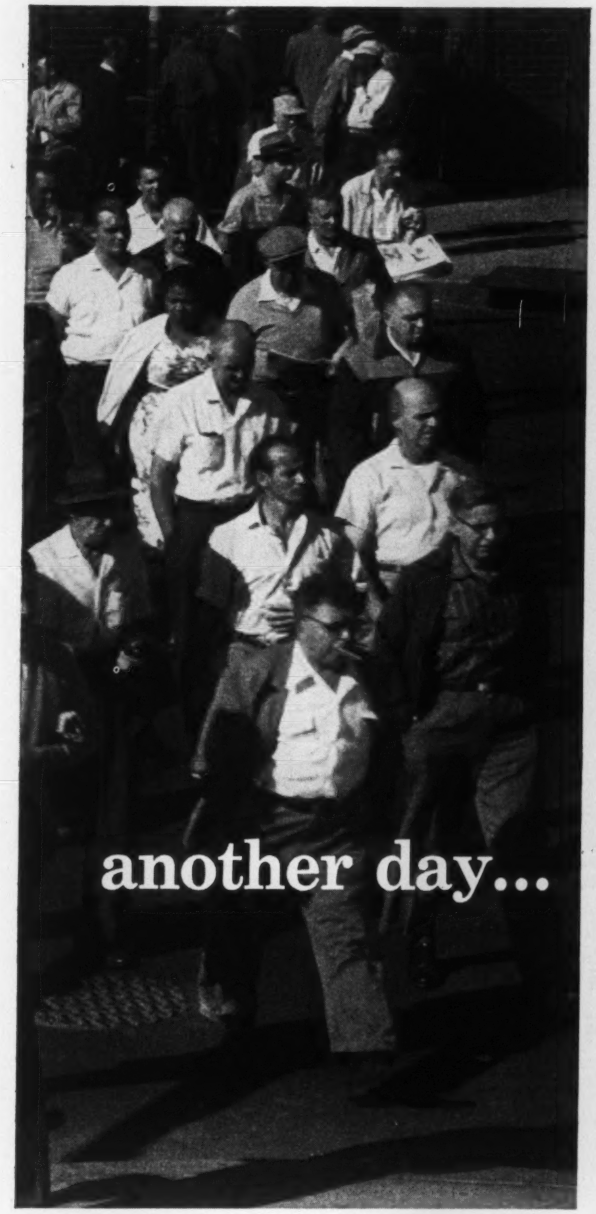

another day...

...another
200,000
corrugated
boxes

In an eight-hour shift, Hinde & Dauch's Chicago plant (just one of seventeen) manufactures as many as 200,000 standard regular slotted boxes. This *volume capacity* is important to H & D customers. It assures them of a virtually limitless supply, a highly reliable source of the boxes they need for sustained production. After all, isn't this the kind of supplier support you'll be demanding during the competitive months to come?

Hinde & Dauch Division

WV West Virginia
Pulp and Paper

HINDE & DAUCH DIVISION, WEST VIRGINIA PULP AND PAPER, SANDUSKY, OHIO • 17 PLANTS • 42 SALES OFFICES

The Arithmetic of Materials Handling

PENNSYLVANIA
102037
UNLOAD

Fuller Airveyor unloads wood flour to two forty-five foot silos. Second Airveyor system reclaims material 360 feet to processing.

General Electric Changes From Bags to Airveyor ... Cuts Handling Costs 60%

As part of a program to increase plastics production and reduce operating costs at its Pittsfield, Mass. plant, General Electric Company called in Fuller engineers to design systems for handling wood flour in bulk.

Wood flour—used as a filler in phenolic molding compounds—was being handled in 75 and 100-pound bags. Unloading one carload of bags required 16 manhours. Bags were loaded on dollies and wheeled to a distant elevator.

SAFETY FIRST—The two pneumatic Airveyor® materials handling systems, engineered and manufactured by Fuller Company, were installed by its parent company, General American Transportation Corp., providing undivided responsibility. This installation resulted in a 60% saving in handling costs! The two systems are handled by one full-time and one part-time operator. Manhours to unload one car have been reduced from sixteen to six!

In addition, all equipment is designed to conform to strict safety specifications set down by G-E engineers.

FLOW *YOUR* MATERIALS—The Airveyor is a system that flows your material through sealed pipes. It's fast, safe, and self-contained. The pipes can be placed close to ceilings, run underground or through walls.

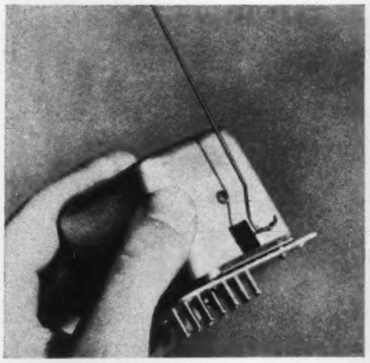
Whether you process wood flour—or other dry granular materials—look into the many economies of Airveyor conveying. Write today for interesting, detailed literature on Airveyor and other Fuller pneumatic materials handling systems.

FULLER COMPANY
GENERAL AMERICAN
TRADE MARK

Fuller
....pioneers in harnessing AIR

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Offices in Principal Cities Throughout the World

G-196
1304



PLUG-IN transducer developed by Electric Regulator Corp. converts mechanical displacements of an input rod into changes in electrical resistance. Responsive to movements as small as 0.0001 inch, unit can handle up to 250 watts of power. Typical inputs are derived from cams, bimetallic elements, fluid pressure on bellows, and tension developed in filaments and webs.

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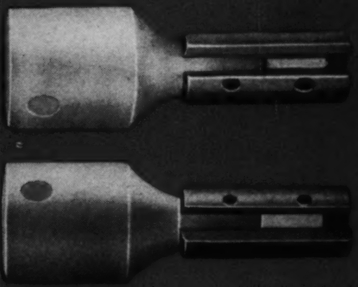
at F. Jos. Lamb Co. . . . **Joseph Surmacz** named plant manager and **David Drewery** appointed director of production and industrial engineering at Harnischfeger Corp. . . . **Joseph B. Rice Jr.** named general manager of the ElectroData Mfg. and Engineering Div., Burroughs Corp. . . . **Robert W. Pearson** appointed to the newly-created staff position of director of production for American Machine & Foundry Co. . . . **Frank R. Wallace Jr.** named manager of manufacturing at Rese Engineering Inc. . . . **E. Sohier Welch Jr.** appointed vice president-engineering of Fenwal Inc. . . . **George A. Peck** appointed president of Southwestern Industrial Electronics Co., Div., Dresser Industries Inc. . . . **Johan H. G. Maters** named executive vice president in charge of manufacturing at Perkin Engineering Corp. . . . **Wilfred H. Tock** has joined the engineering staff of Traylor Engineering and Mfg. Div., Fuller Co. . . . **James S. Locke**, newly elected corporate vice president, named vice president and general manager of Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

SPOTLIGHTING PLANTS

American Chain & Cable Co. Inc. has purchased Electro-Mech Corp., manufacturer of control systems and associated control apparatus. . . . **Hagan Chemicals & Controls Inc.**

DOUBLE
DOUBLE
the service life of ordinary
MAGNETIC
SOCKETS



Cutaway views of Apex reversible magnetic socket, showing magnet in proper position before and after reversing. Magnet is easily repositioned by tapping gently on shank.

APEX REVERSIBLE
MAGNETIC SOCKETS

If you aren't using magnetic sockets, you may be overlooking a good way to trim assembly costs. If you are using magnetics, you can cut costs even more by specifying Apex *Reversible* Magnetic Sockets to get twice as much service from a single socket.

When one end of an Apex reversible magnetic socket becomes worn, simply turn the socket end for end, reposition the magnet, and you'll have a "new" socket ready for work. Sockets are available with a full range of shank types and sizes to fit all popular makes of power and manual drivers.

Here's another way APEX helps you cut fastening costs!

The magnet in any Apex magnetic socket—Standard, Bolt Clearance or Reversible types—can be transferred from a worn socket to a new socket without requiring special tools. Better still, when your Apex sockets become worn, simply return them with your order for new sockets. We'll allow credit for all usable magnets and ship your new sockets promptly. We'll do the work . . . you'll save time, money and labor.

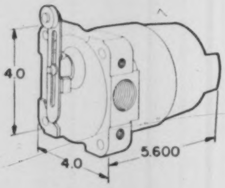
CATALOG 30-A lists the complete line of Apex magnetic sockets, for use with impact tools. Write, on your company letterhead please, for your copy. If you have an unusual fastening problem, we'll quote promptly on special sockets.

APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL
The APEX Machine & Tool Co. • 1036 So. Patterson Blvd. • Dayton 2, Ohio

Circle 673 on Page 19

WEATHERPROOF
EXPLOSION-PROOF

"CX" Precision Switch



"CX" Series Switch
A 20 amp. switch. U/L listed for use in hazardous vapor-air and dust-air atmospheres.

Here's a weatherproof answer for outdoor switch applications and a safe answer in hazardous areas where explosions could occur. All exposed parts of the "CX" are treated to resist corrosion and the cast aluminum housing is sealed against driving rain, dry blowing dust, heat and humidity.

The non-sparking nylon roller actuators and the explosion-proof design make the "CX" safe for areas where dangerous gasoline or lacquer solvent vapors, coal or grain dust collect. The lever arm is adjustable through 360° and from one inch to 3½" in length.

The "CX" contains two single-pole, double-throw switching units, each operated by opposite movements of the roller arm. You can depend on it for rugged switch jobs with hard mechanical service or heavy electrical loads. Don't take chances with explosion hazards. Write for Data Sheet 156 on the weatherproof, explosion-proof "CX" precision switch or call the nearby MICRO SWITCH branch office listed in the Yellow Pages.

75 YEAR HONEYWELL PIONEERING THE FUTURE

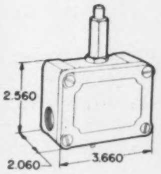
MICRO SWITCH Precision Switches

Don't Risk Explosions in Hazardous Areas!

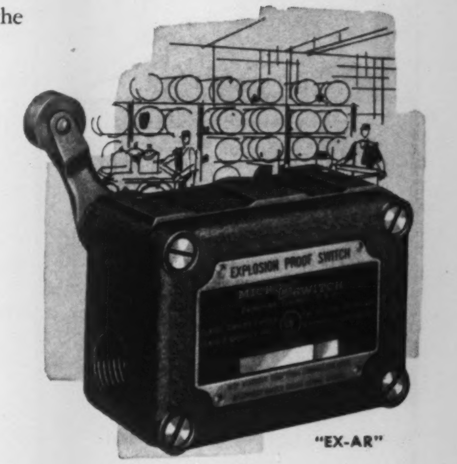
Many different explosion-proof switches are available in the MICRO SWITCH line to help make your plant safer. The nearby branch office or distributor can recommend the right model for performing limit, safety or interlock functions in hazardous areas where dust or vapors might explode. These switches can also cut costs with their automatic control. Be sure of precision and reliability by calling the MICRO SWITCH man. Here are three representative series in the MIRCO SWITCH line of explosion-proof switches:

"EX-AR" Series. These are the smallest explosion-proof switches available. They are rated at 15 amperes and have a roller-arm actuator. Operating force is only ½ to 1¼ lb.

"EX-Q" Series. Rated at 15 amperes and small enough for mounting in cramped installations. Explosion-proof in atmospheres where dust or vapors are a problem. Equipped with a plunger actuator that will withstand a steady load of 100 pounds without injury to the enclosed switching unit. Operating force: 3 lbs. max.

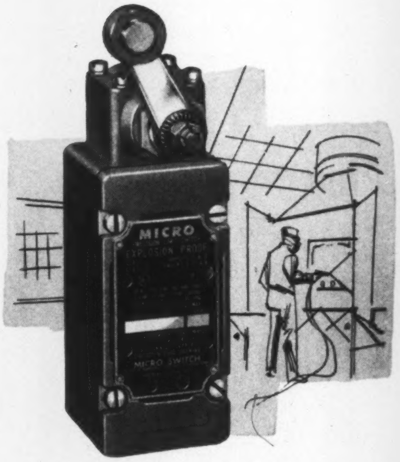


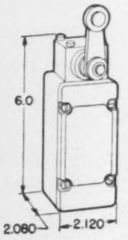
EX-Q (above) has same dimensions as EX-AR.



"EX-AR"

Other "EX" Switches are available with cross-roller lever actuators and manual types. Different operating characteristics and contact arrangements are available to fit varying applications.





"ML-E1" Series. The operating head on these switches is specially sealed against dust and abrasives, perfect for industrial applications where this kind of atmosphere is a problem. Four actuator designs available: low-force rod; roller lever; in-line plunger and roller plunger. These switches are rated at 20 amperes.

Write for Catalogs 83 and 84 on explosion-proof switches.

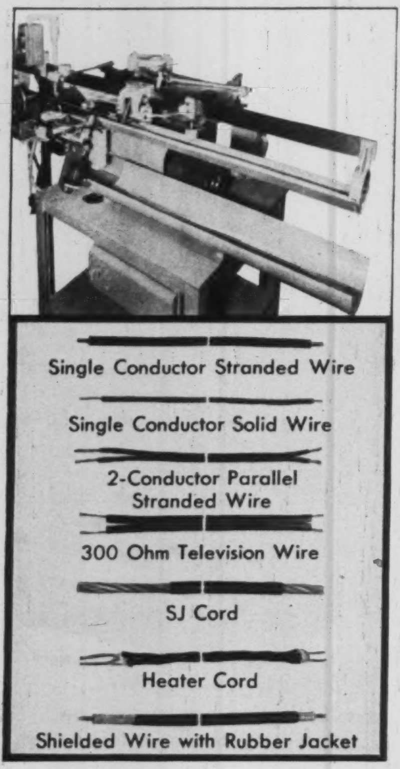
MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Another Time and Labor Saver

for finishing wire leads

with ARTOS AUTOMATIC CS-6


Single Conductor Stranded Wire
Single Conductor Solid Wire
2-Conductor Parallel Stranded Wire
300 Ohm Television Wire
SJ Cord
Heater Cord
Shielded Wire with Rubber Jacket

A new collecting device is now available for use on the popular Artos CS-6 wire-measuring, cutting and stripping machine. Illustration shows the new collecting trough (AE-478). Upper trough collects wire leads up to 60 inches long, then empties into the lower trough after wire has been cut, thus saving operator time.

Production speeds of 3000 finished wire leads per hour up to 15 inches long. Maximum cutting length is 194 inches . . . stripping up to 2 inches at one or both ends. Artos also makes machines that measure, cut, strip and *attach terminals* automatically at one or both ends.

Operated by unskilled labor. Errors and work spoilage, due to human element, are eliminated. Machines are easily set up and adjusted for different lengths of wire and stripping.

Proved performance. Time-consuming hand stripping jobs which once were a bottleneck in many plants are gone forever. As a result, Artos automatic wire strippers are paying their way in the mass production of television and radio sets, electrical appliances, motor controls and instruments of all kinds.

If you need big capacity on wire lead finishing, WRITE for descriptive Artos Bulletin No. 36. Engineering consultation without obligation.

AGENTS
THROUGHOUT THE
WORLD

World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

has occupied a new research facility which will house a pilot chemical laboratory, development facilities for pneumatic control systems and components, model shop for prototypes and experimental devices, and an electronic laboratory for data processing and electronic control equipment. . . . **Allis-Chalmers Mfg. Co.** has combined its Industrial and General Products Divisions into a new operating unit called the Industrial Equipment Div. The new division includes the Compressor, Processing Machinery, Centrifugal Pump, Control, and Industrial Systems Departments plus the Norwood Works motor and pump manufacturing facility. . . . **Consolidated Diesel Electric Corp.** has acquired control of Ultradyne Inc., manufacturer of pressure-to-voltage and pressure - to - frequency transducer systems. . . . **Robertshaw-Fulton Controls Co.** has purchased the Acragage instrument business of International Register Co. and the Microsen instrument business of Manning, Maxwell & Moore Inc. . . . **Pearce-Simson Inc.** has been licensed by Republic Aviation Corp. to manufacture, sell, and service a line of electronic check-out equipment developed by Republic for industrial, marine, and military applications. The line includes an automatic circuit analyzer capable of testing and trouble-shooting 300 electrical circuits within minutes, an automatic servo plotter, and a phase amplitude detector unit. . . . **The Bendix Corp.** will be the new name

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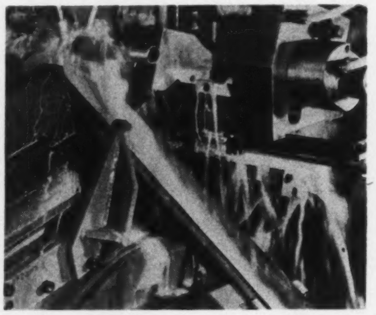
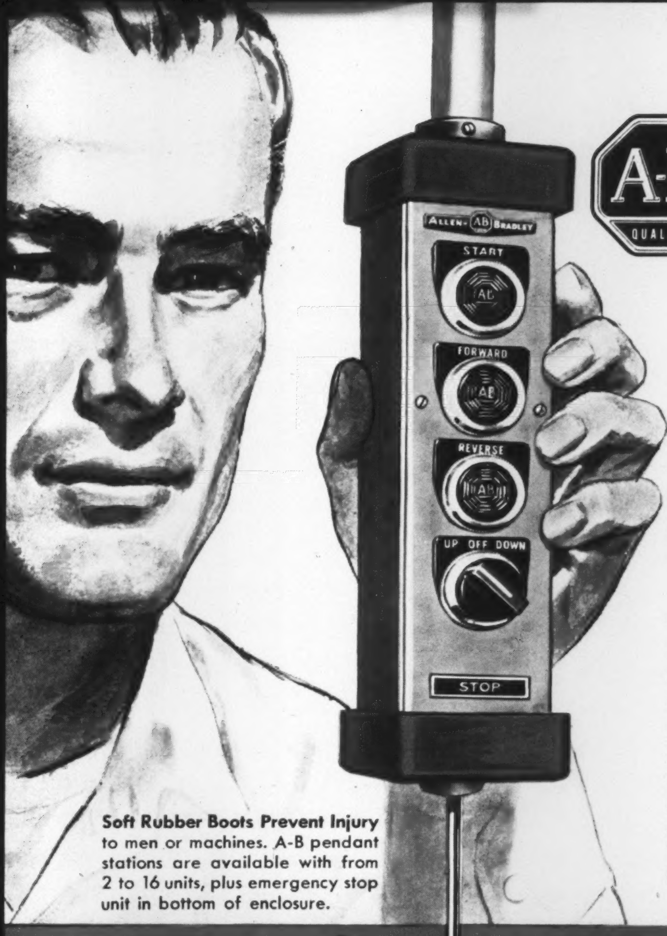


RETRACTABLE work chute, designed to catch finished workpieces as they are cut off on single spindle bar automatics, has been developed by Warner & Swasey Co. Powered by the machine's hydraulic system, the chute automatically moves into position between the cross slides at the proper time to catch the part, then retracts to avoid any interference with subsequent machine functions.



Soft Rubber Boots Prevent Injury to men or machines. A-B pendant stations are available with from 2 to 16 units, plus emergency stop unit in bottom of enclosure.

A-B QUALITY

Allen-Bradley offers the

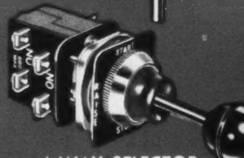
MOST COMPLETE LINE

of oiltight heavy-duty

CONTROL UNITS

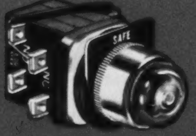
The wide selection of Allen-Bradley Bulletin 800T push buttons and control units will enable you to satisfy each and every control station requirement. A-B control units and stations have seals to exclude oils and cutting fluids—contacts cannot become fouled. And *all* control units have the popular A-B double break, silver contacts that assure reliable operation—without maintenance. The rugged construction, flexibility, and generous wiring room of Allen-Bradley's Bulletin 800T line are "bonus" features. To get the best in every way—insist on Allen-Bradley. Send for Publication 6090, today.

ILLUMINATED PUSH BUTTON
Space-saving two-in-one control unit.

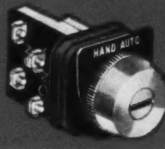


4-WAY SELECTOR SWITCH
Can also be furnished for 2-way operation.

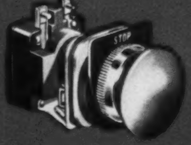
ENCAPSULATED PILOT LIGHT
Transformer type for rugged 6-volt bulb.



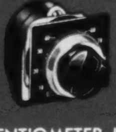
PUSH-TO-TEST
Six different color lenses available.



SELECTOR SWITCH
With coin slot operator. Other operators available.

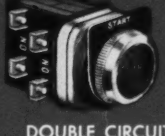


TIME DELAY
Delay adjustable from 0.5 to 5 seconds.

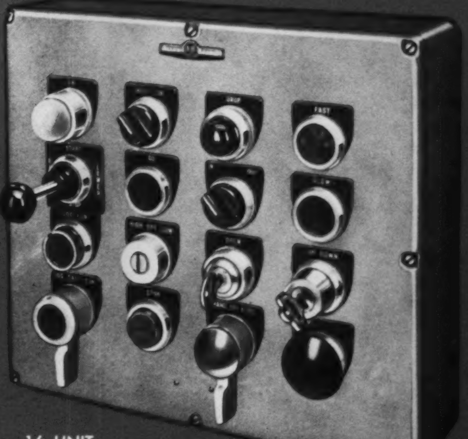


POTENTIOMETER UNIT
Furnished in 2- or 5-watt capacity ratings.

LOCK TYPE
For selector switch or push button operation.



DOUBLE CIRCUIT
Has 2 N.O. or 2 N.C. sets of contacts.



16 UNIT STATION
in die-cast aluminum enclosure. Sheet metal cabinets also available for up to 25 control units.

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Yes, Allen-Bradley also makes...

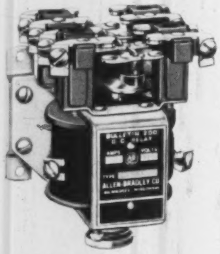
DC Contactors

Here's the only line of DC contactors using the simple solenoid design—with ONE moving part—in all ratings through Size 4. And their double break, silver alloy contacts never need servicing.

BULLETIN 202

DC Control Relays

These relays are the counterpart of the Bulletin 700 line of AC relays—of which millions are in service. With only ONE moving part—these relays provide the ultimate in long life and reliability. Like the AC line, they have double break, silver contacts that never need maintenance. Made in a variety of types and with up to 8 switching poles.



BULLETIN 200

Float Switches

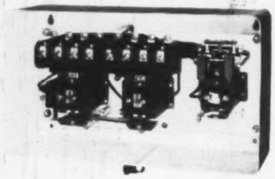
This versatile line of float switches is available in a wide range of types and enclosures to handle practically every industrial pumping job. They all feature a snap-action switch mechanism for positive operation no matter how slowly the liquid level changes.

BULLETIN 840

BULLETIN 1209

Loom Switch

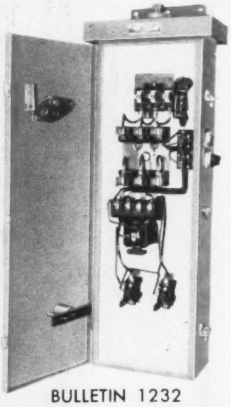
Manual starting switches designed for textile loom service. Design of operating lever makes accidental operation impossible. Lint-tight enclosure eliminates fire hazard.



BULLETIN 1270

Automatic Transfer Switches

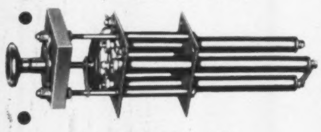
For use where power must be maintained, these panels automatically transfer the load to an auxiliary supply when normal supply fails or falls too low. Transfers automatically when the normal power supply is resumed. Mechanically interlocked.



BULLETIN 1232

Pump Control Panels

Designed for irrigation and oil field pumping applications. Can also be used with outdoor lighting systems. Uses standard A-B Bulletin 709 solenoid starter with manual disconnect switch or circuit breaker in weatherproof enclosure. Available with many optional features.



BULLETIN 410

AC and DC Rheostats

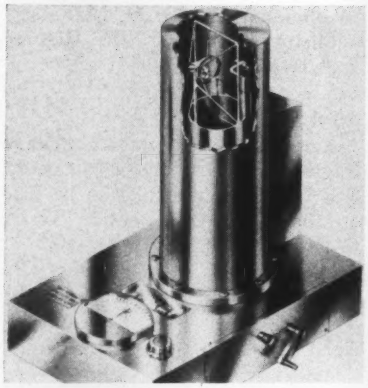
Provide absolutely stepless control over a wide resistance range. Full wattage capacity available at all settings. Sizes to 5400 watts.

6-60-RM

ALLEN-BRADLEY | ***Quality* Motor Control**

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



INSTRUMENT type pressure gages developed by Buck Instrument Co. employ fused quartz elements to provide accurate sensing of relatively low pressures. Typical ranges covered include 0-1, 0-40, 0-80, and 0-120 inches Hg. Low hysteresis, repeatability within 1 part in 30,000, and low temperature coefficient are features of the units.

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of Bendix Aviation Corp. effective June 1. The Computer Div. of the same company has announced that it will build a new manufacturing plant in Los Angeles for continued manufacture of the G-15 digital computer and accessories. . . . **Flo-Tronics Inc.** is the name of a new company formed to supply automated bulk handling systems for the food, chemical, and process industries. . . . **Control Data Corp.** and **Control Corp.** are planning to exchange common stock so that Control Corp. can become a subsidiary of the major company.

MEETINGS AND EVENTS

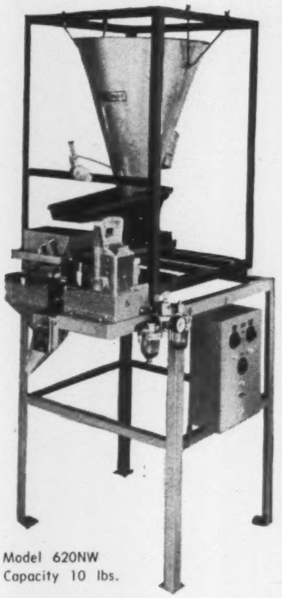
April 11-13—

Fourth Conference on Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION magazine, conference will be held at Purdue University, Lafayette, Ind. For additional information contact K. E. Glancy, Div. of Adult Education, Purdue University or AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

April 18-19—

Third Annual Conference on Automatic Techniques. Sponsored by a national committee including representatives of ASME, IRE, and AIEE, conference will be held at the Cleveland-Sheraton Hotel, Cleveland. Additional details may

EXACT WEIGHT® Automatic Net Weighing Machine



Model 620NW
Capacity 10 lbs.

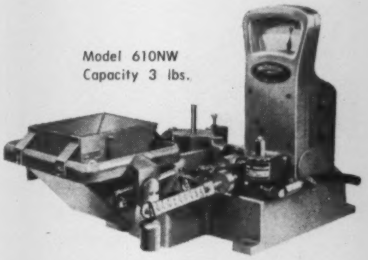
FOR PACKAGING, BAGGING, BATCHING, COMPOUNDING
Exact Weight offers:

- Precision industrial-type scale.
- Over-under indicator visual check eliminating need for separate checkweighing operation.
- Calibrated adjustments with counterweights of known value; graduated beam, poise and scale indicator.
- Design backed by 45 years of experience in specialized weighing equipment.
- Readily accessible service and maintenance facilities.
- Performance guaranteed in writing.

Weighs and feeds any dry, free-flowing materials . . . fast and accurate operation . . . helps cut production costs. Write for Bulletin 3318 for details and specifications.

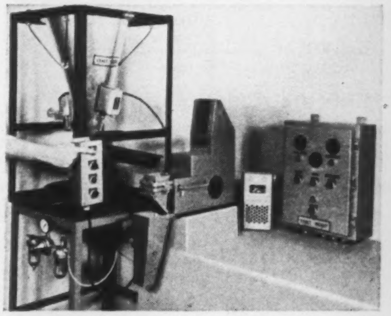
Automatic Net Weigher

Net Weigher can be supplied without the feeder machine, support frame and discharge chute. The unit may be adaptable to your specific operation. Write for Bulletin 3311.



Model 610NW
Capacity 3 lbs.

Precision Automatic Net Weighing Machine



Model 4601NW, left, for weighing dry products with accuracies of 1/10 gram on quantities below 10 grams and one percent accuracy on quantities of 10 grams and above. Combines a high - accuracy Shadograph Scale, air-operated dump mechanism, hoppers, vibratory feeders and photoelectric controls. Models with capacities from 50 grams to 500 grams. Write for Bulletin 3363.

Exact Weight SCALES

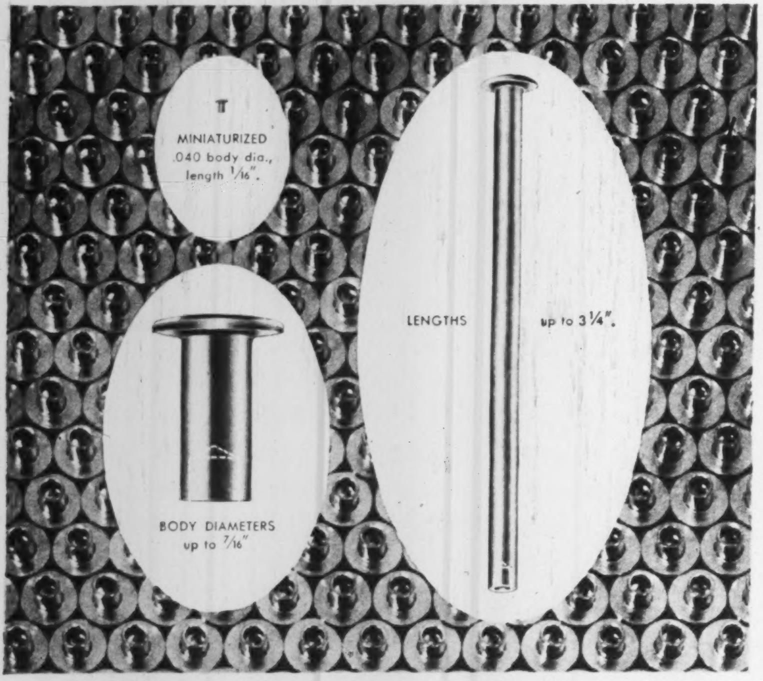
THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Sales and Service Coast to Coast

Find us in your local 'Yellow Pages'

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

Look at this Size Range of Semi-Tubular Rivets... it's the way to lower cost



Miniaturized components and also large complete assemblies can now have all the money-saving advantages of using single and multiple automatic riveting. This is due to the wider size range of semi-tubular rivets now available and which can be used in conjunction with motor and pneumatic driven automatic riveting machines.

Today, there is hardly a fastening problem, involving even fragile materials, that does not warrant consideration of low-cost semi-tubular rivet setting.

Our Factory Riveting Specialists are ready to help you obtain the REAL COST FACTS on your own specific fastening problem. There is no obligation.

FOR YOUR FILES
Chicago Rivet Catalog describes 1388 standard tubular and split rivets and 25 single and multiple automatic rivet setters.

AIR-POWERED RIVETING
contains description and specifications of 8 single, multiple riveters— also rivet setters designed for automated operation.

Chicago Rivet & MACHINE CO.
943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb)
Branch Factory: Tyrone, Pa.

Circle 679 on Page 19

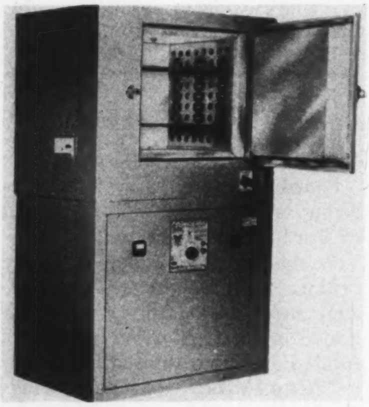
be obtained from J. H. McRainey, publicity chairman, 1213 W. 3rd St., Cleveland 13, Ohio.

April 19-21—
American Society of Lubrication Engineers. 15th Annual Meeting and Lubrication Exhibit to be held at the Netherland Hilton Hotel, Cincinnati. Further information is available from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

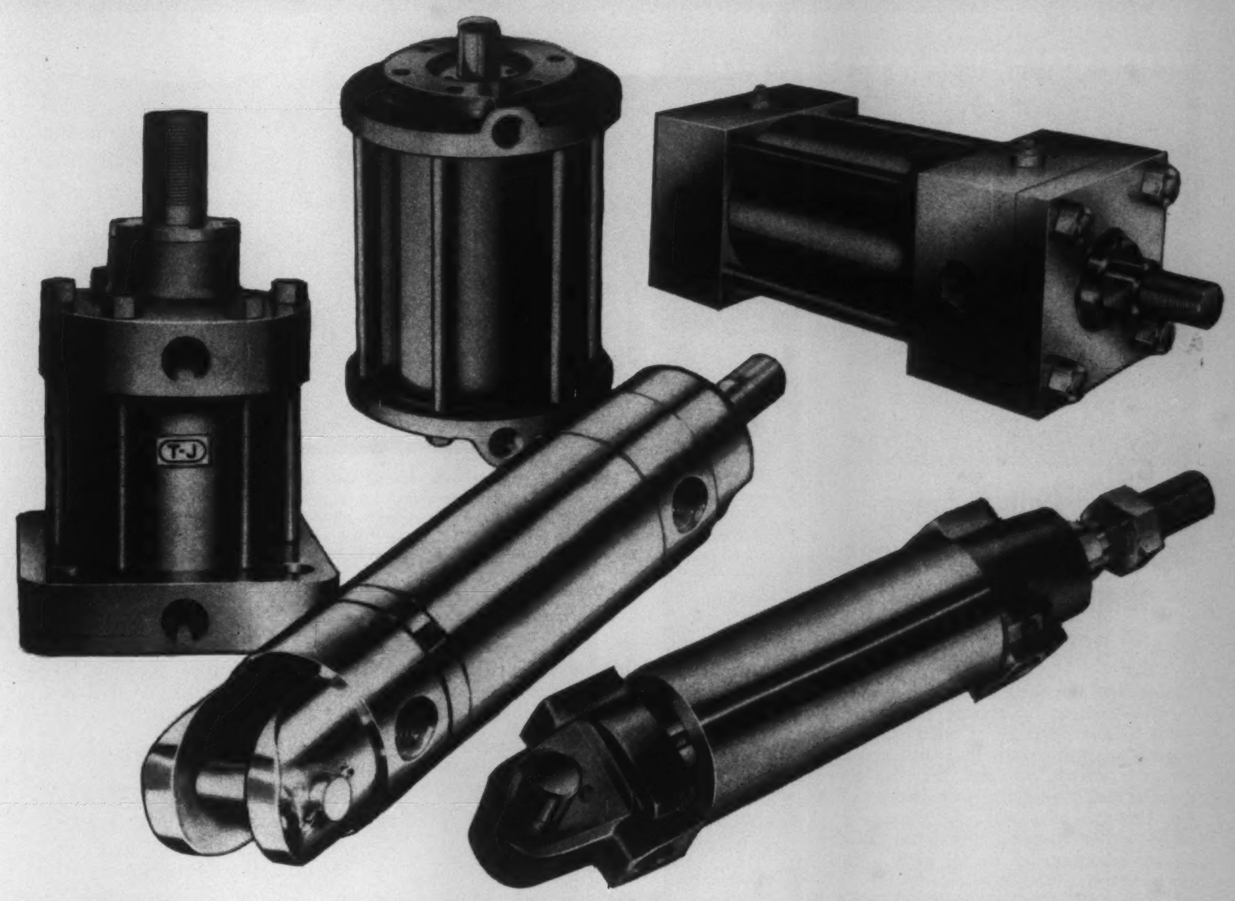
April 21-28—
American Society of Tool and Manufacturing Engineers. Tool Show and Annual Convention to be held in the Artillery Armory and the Sheraton-Cadillac Hotel, Detroit. For additional information contact H. E. Conrad, ASTME headquarters, 10700 Puritan Ave., Detroit 38, Mich.

April 25-29—
American Welding Society. 41st Annual Convention and Welding Exposition to be held in the Biltmore Hotel and the Great Western Exhibit Center, Los Angeles. Further information may be obtained from AWS headquarters, 33 West 39th St., New York 18, N. Y.

April 27-29—
Instrument Society of America. Sixth Annual Southeastern I.S.A.



ELECTRIC convection-type oven manufactured by Blue M Electric Co. utilizes a saturable power reactor in combination with a stainless steel hydraulic bellows and variable gap inductor for stepless, proportional band control of temperature. Static control system requires no auxiliary contacts, electronic amplifiers, or timing devices. Resistive heater load automatically receives proper amount of power to sustain temperature losses, with compensation for line voltage and ambient temperature changes.



For Your Power Drive • Design • Application or Replacement Maintenance

There's a T-J CYLINDER

That Can Assure *Accurate* *Efficient* *Operation*

Only T-J's complete line can assure you a cylinder of either air or hydraulic application – with practically limitless design specifications for bore, stroke, pressure range and even delivery requirement. From the time-tested, standard tie-rod air and hydraulic, to the exclusive T-J Spacemaker, and including the recently introduced Squair Head, T-J cylinders give you more features for efficient, long-lasting operation. Write today!

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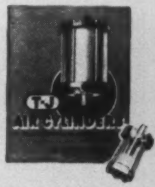
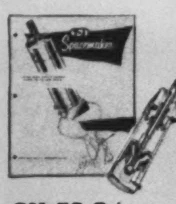
HYDRAULIC CYLINDERS

H-47 for standard tie-rod hydraulic cylinders.

SQ-1058-4 for the T-J Squair Head cylinder.



No. 54 for standard tie-rod air cylinders.



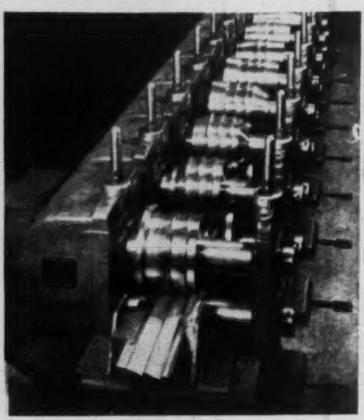
SM-56-3 for the incomparable Spacemaker cylinder.

HSM5-58-4 for the High-Pressure Hydraulic Spacemaker cylinder.

THE TOMKINS • JOHNSON CO. JACKSON, MICH.

CYLINDERS • MILLING CUTTERS • RIVETERS and CLINCHERS

Circle 680 on Page 19



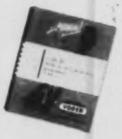
Yoder Roll-Forming Equipment mass-produces shapes accurately, economically

Yoder Roll-Forming Equipment, even with part-time operation, can effect significant savings in many metal working applications and industries. Shapes, simple or complex, can be quickly and economically produced the Yoder way from a wide variety of flat-rolled coated or uncoated stock . . . in thickness up to ¾ inch . . . in speeds up to 50,000 feet per day.

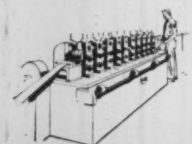
Yoder engineers flexibility and precision into metal forming operations. For example: many basic shape modifications, such as coiling, welding, notching, ring-forming, perforating, and cutting to length can be simultaneously accomplished with little or no additional labor cost.

Yoder also makes a complete line of Rotary Slitters and Pipe and Tube Mills. Profit from Yoder's years of engineering and service experience, contact your local Yoder representative or send for the Yoder Roll-Forming Manual.

This fully-illustrated 88-page book clearly discusses every important aspect of Yoder Roll-Forming Equipment and methods . . . it's yours for the asking!



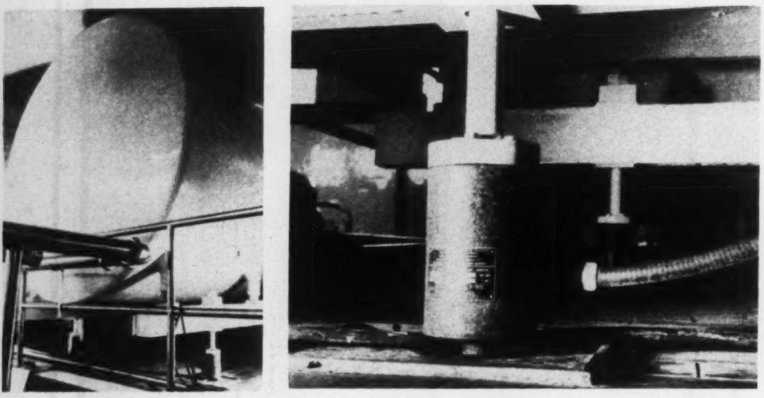
THE YODER COMPANY
5526 Walworth Avenue • Cleveland 1, Ohio



ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES

Circle 681 on Page 19



WEIGHING system for this 5000-gallon milk storage tank at Thompson's Honor Dairy Inc. employs four strain gage-type load cells developed by the Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp. System weighs contents of tank to an accuracy of 0.05 per cent, and serves as a check on volume gages used with farm bulk tanks. Right view illustrates mounting arrangement for one of four 20,000-pound capacity load cells used to support the tank.

Conference & Exhibit and First Pulp and Paper Division Symposium will be held in Municipal Auditorium and San Carlos Hotel, Pensacola, Fla. Further information is available from W. H. Matthews, P.O. Box 4426, Pensacola, Fla.

May 3-5—

National Association of Relay Manufacturers. Eighth Annual Conference on Electromagnetic Relays to be held at Oklahoma State University, Stillwater, Okla. For more information write Prof. C. F. Cameron, National Association of Relay Manufacturers, P.O. Box 6, Stillwater, Okla.

May 3-5—

Western Joint Computer Conference. Conference and exhibit to be held in Jack Tar Hotel, San Francisco. More details are available from W. C. Estler, 965 Lincoln Ave., Palo Alto, Calif.

May 9-12—

Instrument Society of America. Second ISA Instrument-Automation Conference and Exhibit of 1960 will be held in Civic Auditorium and Brooks Hall at San Francisco. Additional information is available from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

May 9-13—

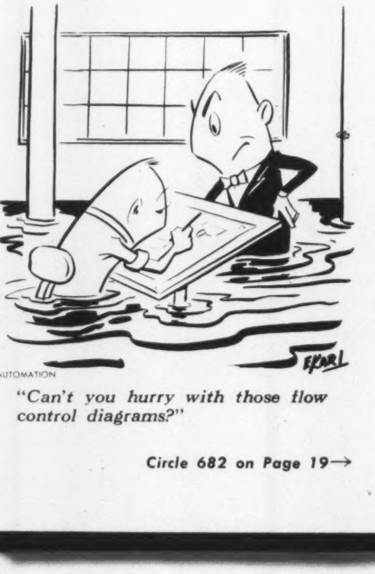
American Foundrymen's Society. Castings Congress & Exposition to be held in Convention Hall, Philadelphia. For details contact AFS headquarters, Golf and Wolf Roads, Des Plaines, Ill.

May 11-13—

Material Handling Show & Packaging Cavalcade. Third Western Regional Show sponsored by American Material Handling Society, Los Angeles Chapter, will be held in Great Western Exhibit Center, Los Angeles. Information is available from A. B. Perkins, 2807 Sunset Blvd., Los Angeles 26, Calif.

May 12-14—

American Institute of Industrial Engineers. Eleventh Annual National Conference and Convention to be held at Sheraton-Dallas Hotel, Dallas. Details on request to AIIE, P.O. Box 914, Irving, Texas.



AUTOMATION

"Can't you hurry with those flow control diagrams?"

Circle 682 on Page 19→

RW-300

the most field-reliable computer control system . . .

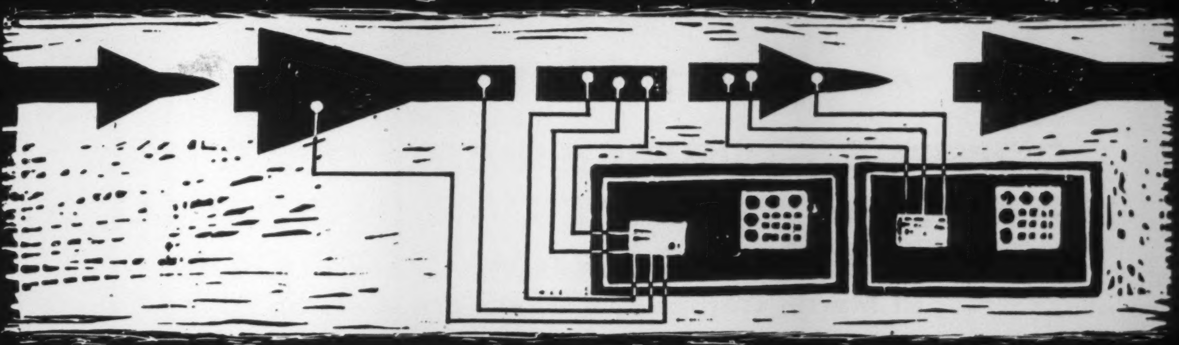
FOR AUTOMATIC CONTROL OF PRODUCTION TESTING

Through automatic testing of complex components, assemblies, and complete systems, the RW-300 Digital Control Computer can significantly reduce test time, improve quality control, and lower manufacturing costs.

As the central unit of a versatile automatic testing system, the computer releases highly trained technical personnel from repetitive testing duties and the detailed design of special testing equipment. Computer control eliminates human error and provides test routines that are exactly reproduced time after time. Unlike special test equipment that must be redesigned to meet new requirements, the RW-300 system permits test routines to be modified or completely changed merely by reprogramming the computer.

Leaders in missile, electronics, and other industries are now introducing the RW-300 into production testing. They take confidence in the fact that it is the only digital control computer already proved out in more than a dozen on-line industrial applications.

For further information, call or write Mr. Raymond E. Jacobson, Director of Marketing, Dept. 1078.



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a division of *Thompson Ramo Wooldridge Inc.*

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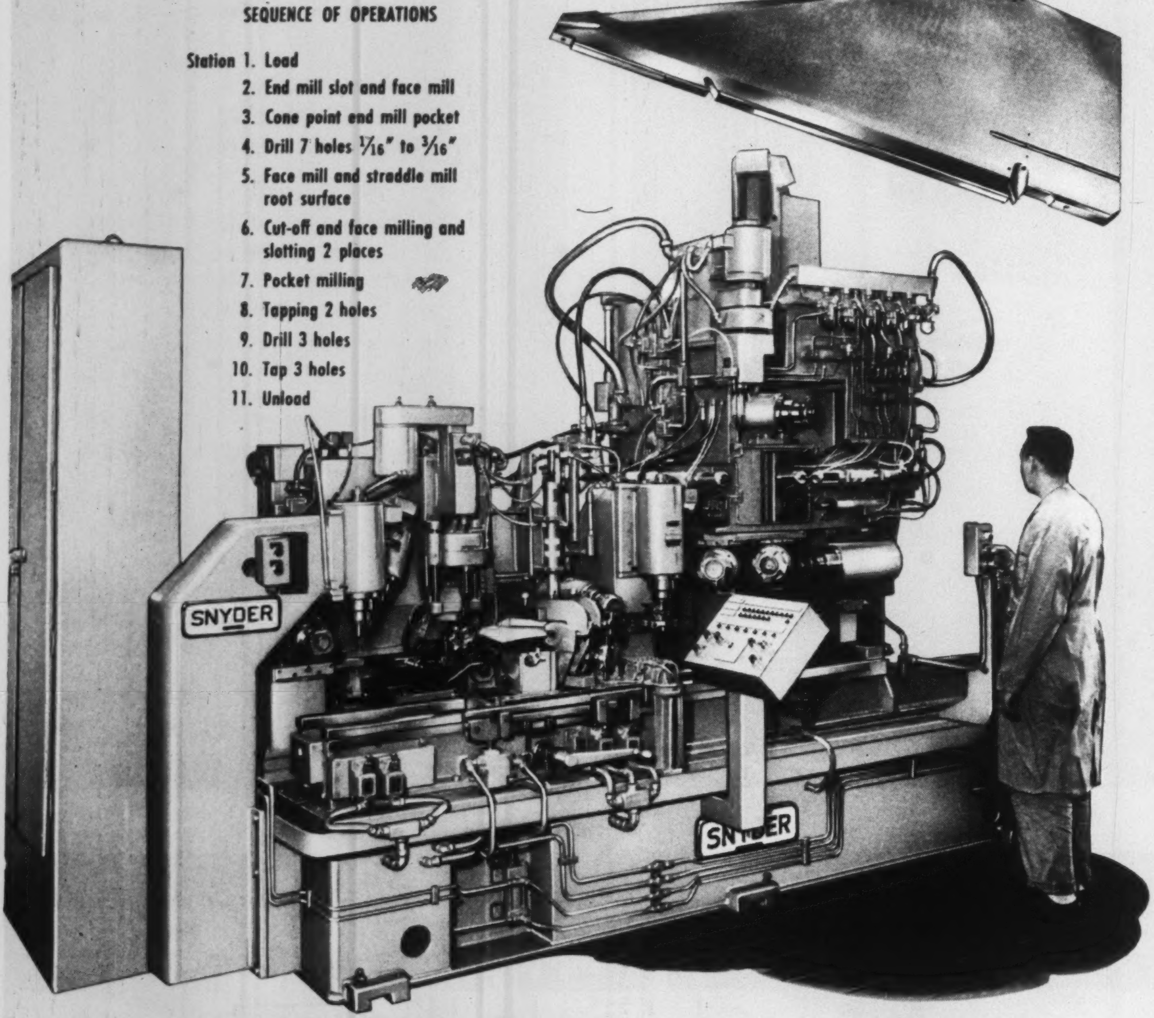

SEQUENCE OF OPERATIONS

Station 1. Load
2. End mill slot and face mill
3. Cone point end mill pocket
4. Drill 7 holes 1/16" to 3/16"
5. Face mill and straddle mill root surface
6. Cut-off and face milling and slotting 2 places
7. Pocket milling
8. Tapping 2 holes
9. Drill 3 holes
10. Tap 3 holes
11. Unload

COMPLEX MISSILE WING GETS 24 PRECISION OPERATIONS IN SPECIAL SNYDER PROGRAMMING TOOL

at Martin Company's Baltimore Division

Production rate, tolerances and part configuration dictated the fundamental design concept of this exceptionally compact tool which has 11 stations and performs 24 operations.

The cycle can be automatic, semi-automatic or manual. Controls for multiple cycle operations are provided by utilizing basic circuits triggered by a programming control device.

SNYDER
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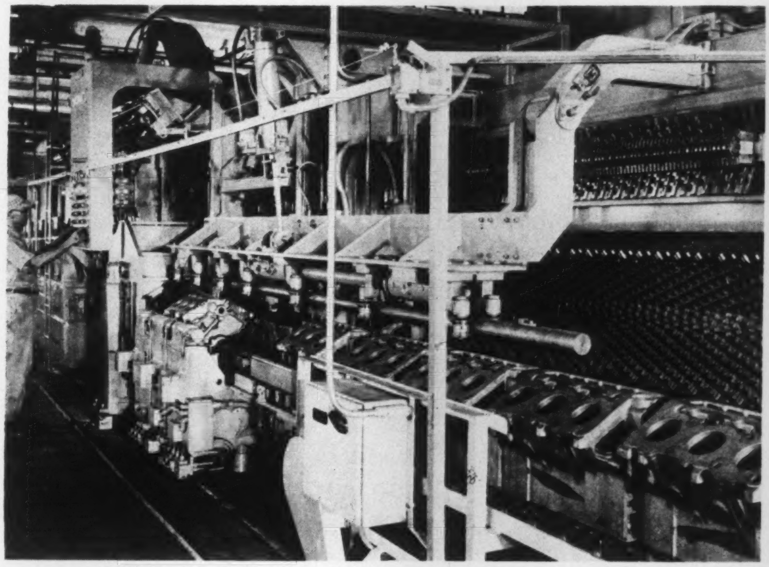
Circle 683 on Page 19

detroit dateline

By JAMES C. KEEBLER *Managing Editor*



Cylinder block broaching machine at GMC Truck and Coach Div. handles both V-6 and V-12 models. Here a line-up of V-6 blocks is ready to pass through the machine. Top, bottom, and bearing half surfaces are machined in a two-station setup.

Clean Sheet of Paper

IT has been observed that one of the marks of a good designer is a willingness to tear up a design and start over again with a clean sheet of paper. There is a stubbornness in many of us that refuses to accept the fact that the tangible results of a few hours effort may serve their best purpose by filling a wastebasket, and thereby freeing the intangible results (increased knowledge) to be used to create a new design unhampered by the existence of lines previously fixed on a paper.

This reluctance to start again from scratch may be the result of a feeling that to make a false start is to display incompetence, and certainly the fear of failure has kept many a good idea from being launched. Yet, lest it be considered that the best designer is the guy with the biggest wastebasket, let us recognize that with maturity the more competent creative minds learn when to stick it out with the first draft and when to have another go at it.

Starting over again brings with it a freedom that cannot be obtained by trying to do-over an existing configuration. Like all freedoms, this blank sheet of paper carries with it certain responsibilities. Chief of these is the duty to reflect in the new design the fullest advantages of the experience gained from previous efforts.

Blank Sheet of Plant

In a like manner nothing gives the manufacturing engineer greater freedom, nor a larger challenge, than the decision of his corporation to build a new plant to manufacture the product he's working with. This is like a reprieve from the punishment of living with past errors—a chance to go straight.

Recently our editorial offices were visited by a subscriber from the other side of the Atlantic whose corporation plans to build a new automotive stamping plant. His mission in the USA was to learn the most he could about the previous experiences of others so that his company's investment might purchase the best available modern technology. The designer with a blank plot of ground may go to considerable extent in avoiding his previous errors—and the errors of others.

It is not every day that a foreigner with $30 million in his jeans drops in for advice on how to spend it. His approach was realistic, his observations of interest. In touring US automotive stamping plants he wanted to see the latest installations and discuss the problems with those who solved them. Equipment builders were considered a good source of leads. He observed a co-operative willingness on the part of US automakers to show (or show off) what they have. Yet, there was a realization that the thinking and planning includes improvements not yet on the production line, and that the builder's viewpoint may include certain prejudices not revealed in a conversation.

The American technical journalist is credited with being on the vantage point of progress — in a position to see many sides of a question and evaluate them without bias. This involves more than merely editing out the superlatives. When drawing conclusions one must first ascertain whether or not he has gathered sufficient facts from which to sum up a situation.

Design Co-ordination

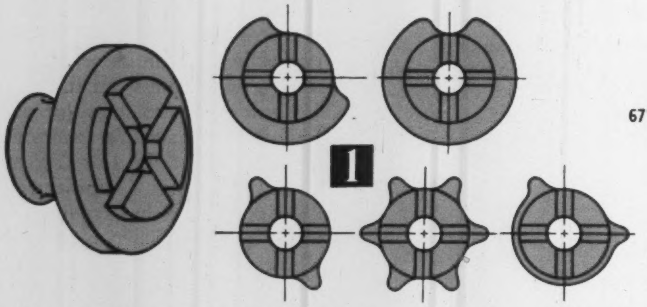
One facet of the present state of the art that bears close investigation is the emphasis being placed upon co-ordination of product design and production facility design. In this age of production systems designed especially for a given product we find products being designed especially for production by advanced manufacturing techniques.

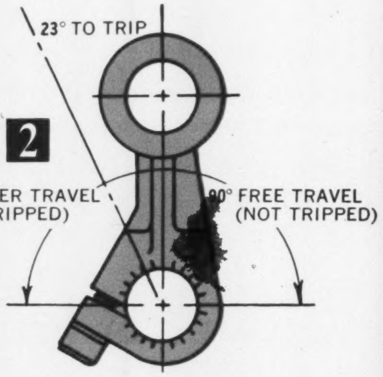
This is nothing new to the tinsmith who designs ductwork so that it can be made with the tools he owns, and purchases new tools to

The SL2 snap-lock•Newest NAMCO Machine Life Limit Switch

Snap-Lock Limit Switches, developed by National Acme to meet rigid specifications, have become industry's standard for reliable "machine life" service. Latest and most advanced in the complete line is the SL2. Built with machine tool precision and ruggedness, it will give millions of fast, accurate contacts. Furthermore, it is water and oiltight and can stand the bruising conditions imposed by heavy-duty machine applications. You owe it to yourself to closely examine the *combination* of performance characteristics that assure completely reliable limit switch performance under the most extreme operating conditions.

Closely Check These Outstanding Features





1. Flexible Operation . . . To meet the requirements of any application, standard cam blank (above, left) can be cut into a wide variety of configurations including those shown. Interchangeable, these cams provide positive control of contact sequence; permit tailoring switch performance to individual jobs.

2. Ample Overtravel and By-pass . . . Sixty-seven degree overtravel . . . 90° by-pass . . . 180° arc.

3. Clockwise or counterclockwise motion . . . Converting from clockwise to counterclockwise motion takes but a few seconds.

4. Light Operating Pressure . . . Tripping action requires only 12½ pounds at 1½ inch radius . . . 50% less than previous models. Overtravel reduced so as to require only 8 pounds at 1½ inch radius.

5. Shock-proof Design . . . Positive mechanical lock mechanism withstands shock and vibration.

6. Fast Contact Action . . . High make-and-break contact speed permits use in unusual applications.

7. High Contact Pressure . . . Contact bounce minimized by use of new contact material that permits 15 oz. contact pressure.

Write for Bulletin EM-SL60 containing complete detailed information

National Acme

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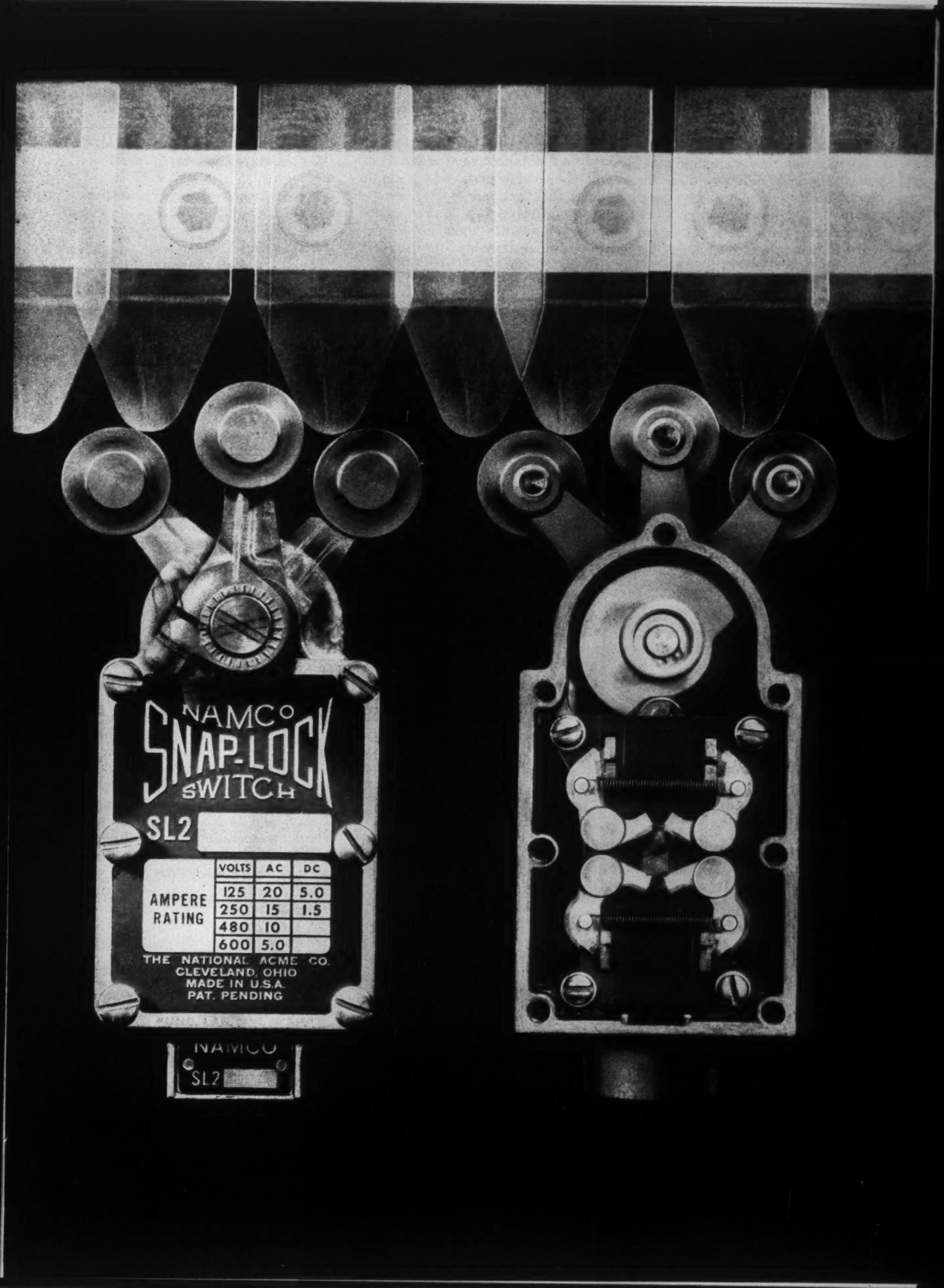
Sales Offices: Newark 2, N.J.; Chicago 6, Ill.; Detroit 27, Mich.

Circle 684 on Page 19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SNAP-LOCK
SWITCH
SL2
VOLTS AC DC
AMPERE RATING
125 20 5.0
250 15 1.5
480 10
600 5.0
THE NATIONAL ACME CO.
CLEVELAND, OHIO
MADE IN U.S.A.
PAT. PENDING
NAMCO
SL2

make the kind of ductwork he wants to produce. Where one man is the whole show, this is a natural method of operation.

So the next new stamping plant will likely look different than the newest in operation—if for no other reason than differences in product. The designer must be a competent judge of history and distinguish between those features of existing installations that represent sound basic technology, those features that are applicable primarily to the case at hand, and those that fall short of expectations.

One of this nation's newest auto plants reflects the trend toward more teamwork between specialized engineering departments. GMC Truck and Coach Div., has a new engine plant to make V-6 and V-12 gasoline engines. In releasing the story of this development GM revealed that the engineering department had started with a "clean sheet of paper" on the design of a new line of engines, and the production department started with an equally unfettered program in creating a manufacturing plant to build these engines. Blending of product design and manufacturing facilities achieved in this plant required that the engineers in both departments work in harmony. Literally the plant and the product were designed together.

Family Design

The new 6 and 12-cylinder engines are a "family design" including a wide range of power plants with an unprecedented number of interchangeable parts. As a result many identical manufacturing operations are repeated for the entire range of engines right up to the time of final assembly. Out of 580 manufacturing operations on the line of V-6 engines, over 540 apply also to parts for the V-12. Considering the V-12, which requires 900 operations, more than half apply also to the 6-cylinder engines progressing over the same line of machine tools.

To cite an example, the 12-cylinder block is approximately twice the length of the six, but the end facing is the same so that the end milling operations are performed on the same machines. Sixes and twelves are put through in separate groupings, with only a quickly made adjustment necessary in the automatic transfer mechanism that shifts the blocks on the carrier conveyor feeding the machines.

Blocks are machined on a 100-ton broach that surfaces top and bottom faces on the first station and does the bottom bearing cap surfaces and the half-rounds on the second station. The size and power capacity of the machine were designed to take care of the 12-cylinder blocks and the tooling arranged to handle both sixes and twelves.

Machinery in this plant includes 192 new special machines built by 100 specialists from many parts of the country. In addition 75 existing machines were integrated into the new program.

Plant Systems

Auxiliary systems were installed to take care of dirt and chips. At points along the machine tool lines where residual chips, grit, or dust would be harmful to operations the parts are cleaned by automatic washing equipment. Overhead dust collecting ducts are part of a system devoted to cleanliness.

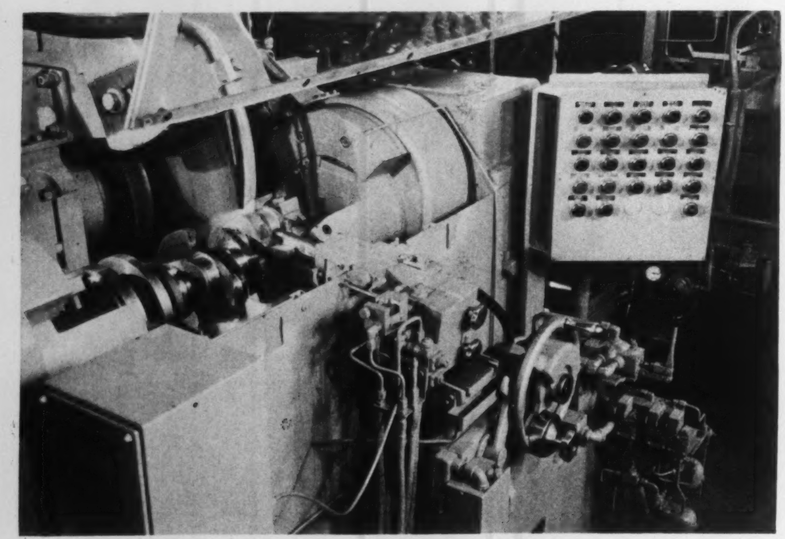
Underfloor chip disposal systems were installed in heavy grinding and machining areas, and a central coolant system was provided. During the three years required to design and set up this plant ready for production, each individual operation was studied so that it could be incorporated in its proper place.

Three-dimensional scale models were used to study all phases of the production layout, establish locations of machines and foundations, pits and conveyor systems, and all service and maintenance facilities.

Layout for 6-cylinder crankshafts accommodates shafts of two different materials requiring different cutting tool materials or machining specs. One is cast and is used in the higher production light-duty engines; the other is forged steel, used in the heavy-duty engines. Rough and finish turning and the checking operations are performed on different machines. These are located in parallel lines with the flow of shafts in the same direction. After these preliminary operations the two types proceed together on the same line for all milling, drilling, grinding and balancing.

There is a special automatic pin grinding machine which provides a ground fillet held to extreme accuracy to eliminate change in the contour of the fillet which could cause a line of weakness, and crankshaft failure. This machine automatically dresses the wheel after each grind.

The plant is loaded with examples of what can be done when the engineers are given a clean sheet of paper and the wherewithal to fill it.



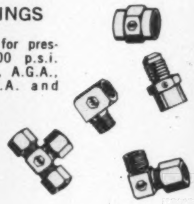
One of seven grinders in the crankshaft line at GMC Truck and Coach Div. engine plant, this machine grinds fillets with a precision designed to eliminate possibility of crankshaft failure at these critical spots. This is a new piece of machinery in the industry.

WEATHERHEAD

fittings and hose assemblies

"MADE BETTER TO SERVE BETTER"

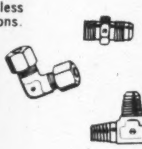
brass FITTINGS



⅛" to 1" sizes for pressures up to 5000 p.s.i. Approved by U.L., A.G.A., A.S.M.E., A.S.A. and S.A.E.

S.A.E. 45° Flare
Compression
Selfalign®
Threaded Sleeve
Inverted Flare
Pipe

forged steel FITTINGS



For flare and flareless pressure connections. Sizes ⅛" to 2" in carbon or stainless steel for pressures to 10,000 p.s.i.

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Flare-Twin
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Twenty different styles available. From ¼" to 2" O.D. for working pressures up to 10,000 p.s.i.

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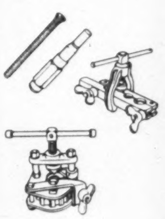
Completely fabricated with permanently attached swaged ends. Any size, any quantity for working pressures up to 10,000 p.s.i.

reusable hose ends

Designed for fast assembly and positive, leak-proof performance under high pressures.

tube working tools



Designed for fast, accurate fabrication of all types of tubing layouts.

Tube Cutters
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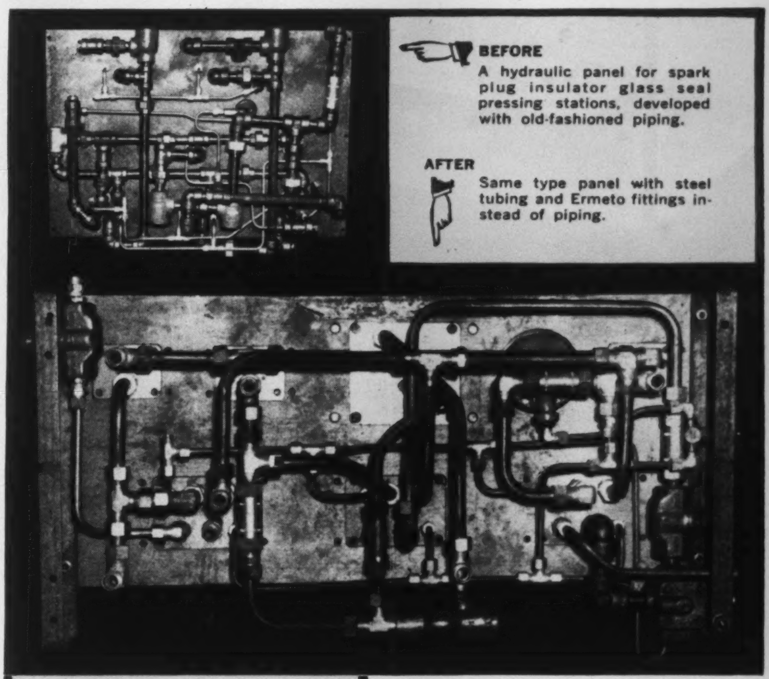
Write for new general catalog—contains complete data and specifications for all items.

Screw machine parts made to your specifications . . . any machinable material. Write for information.

AWARD WINNING IDEAS...

"Ermeto Fittings Save $2000 Worth of Maintenance Labor Annually"



BEFORE
A hydraulic panel for spark plug insulator glass seal pressing stations, developed with old-fashioned piping.

AFTER
Same type panel with steel tubing and Ermeto fittings instead of piping.

Idea submitted by:

William T. Bayley
A.C. Spark Plug Division, G.M.C.
Flint, Michigan

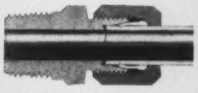
The photographs above show *before* and *after* views of hydraulic panels for a spark plug insulator assembly application which uses a petroleum base fluid operating under 700 p.s.i. at 115°F. Six machines were originally piped as shown in the *before* photograph. As Mr. Bayley states, "Considerable leakage at the many pipe threads was encountered, resulting in frequent maintenance. Oil leakage of these *before* units eventually resulted in operator injury.

"The *after* photograph shows one of the six panels repiped with Ermeto fittings and steel tubing. The results have been a 100% reduction of maintenance and oil leakage, reduced turbular flow, with a much neater installation operating at smoother and cooler rates.

"Ermeto fittings were selected because they were proved best from our tests. The superior grip on the tubing by Ermeto fittings survives shock and vibration, resulting in fewer leaks and less maintenance.

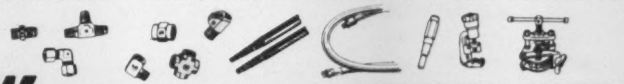
"The savings in maintenance of the six units *after* repiping amounts to approximately $2000 a year. This is chiefly in labor."

Find out how Ermeto fittings can help you reduce maintenance costs and improve system efficiency . . . *write today.*



Ermeto hydraulic fittings are unmatched for positive high pressure control. Available in stainless or carbon steel with "Weathercote" or Cadmium finish in ¼" to 2" sizes.

BRASS & STEEL FITTINGS / HOSE & ASSEMBLIES / TOOLS & ACCESSORIES



WEATHERHEAD

THE WEATHERHEAD CO., FORT WAYNE DIVISION
Dept. A-4, 128 W. Washington Blvd., Fort Wayne, Ind.
In Canada:
The Weatherhead Co., Ltd., St. Thomas, Ont.

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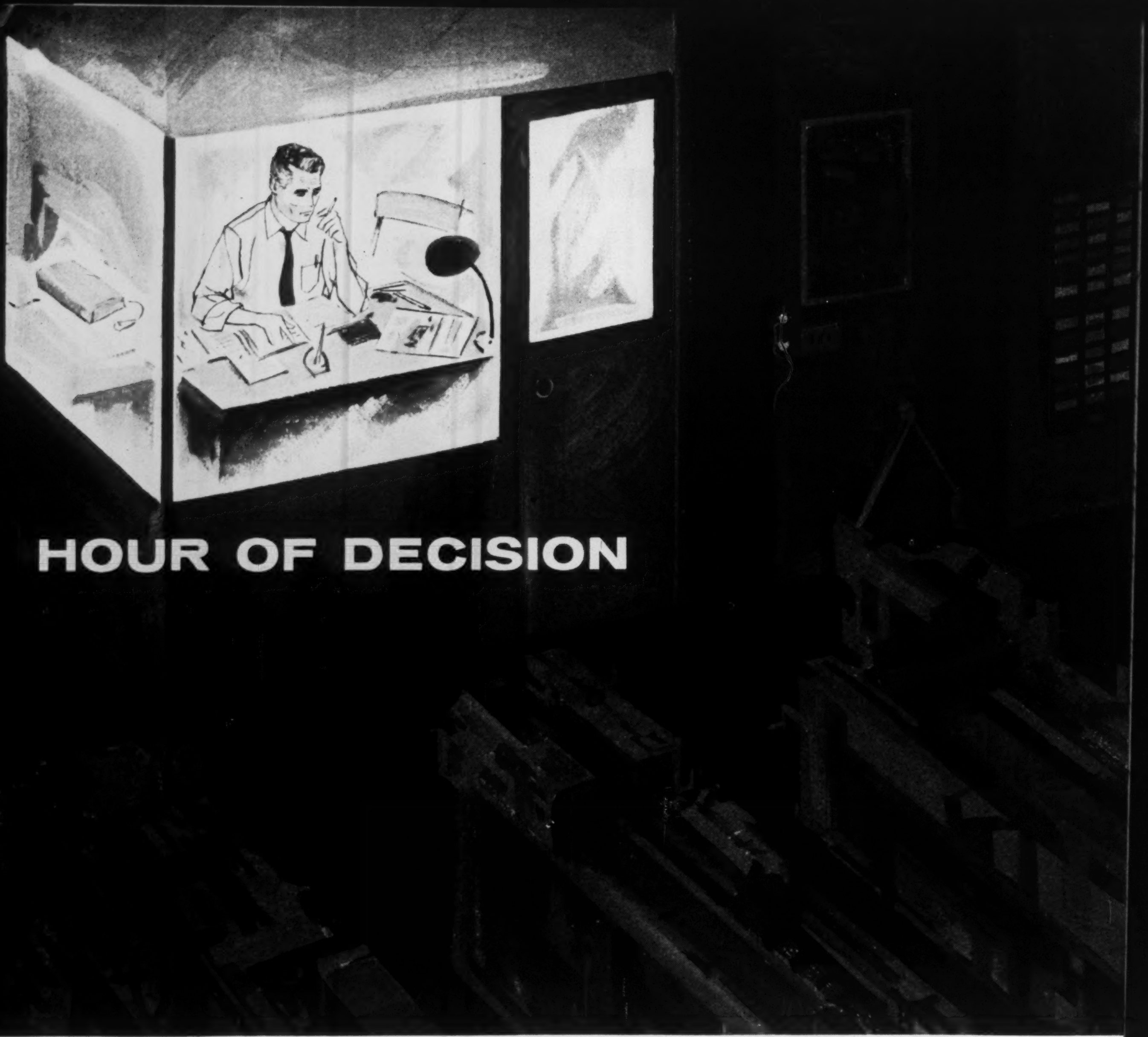

HOUR OF DECISION

After hours? — sure You're not surprised at that because you know it's when he (and probably you, too) concentrates on the problems which are vital to his company's continued successful growth. The day is filled with production crises, maintenance problems, personnel questions, and committee meetings. It's only now that he can really study the facts and decide what's best.

Right now he's reviewing his machine tool inventory. He's amazed at how old some of his equipment is getting to be. It seems only yesterday that he signed the purchase order for it to increase his capacity for World War II. But that was 1943, seventeen years ago! No wonder maintenance is getting high and efficiency is dropping off.

We've got a suggestion for this man (and for you, too). Attend THE MACHINE TOOL EXPOSITION — 1960 and see for yourself why Modern Machine Tools = Production Efficiency. This exhibit, the first since 1955, is sponsored by The National Machine Tool Builders' Association* and will contain eleven acres of the U.S.A.'s newest machine tools under power, cutting and forming metal to demonstrate 1001 ways to lower production costs. Can you afford to stay home?

You're also invited to the PRODUCTION ENGINEERING SHOW on the Navy Pier.

No extra registration needed.

*The N.M.T.B.A. represents 90% of the U.S.A. machine tool industry.

FORMULA FOR TOMORROW

MODERN MACHINE TOOLS
MMT=PE
PRODUCTION EFFICIENCY

International
Amphitheatre
Chicago, Illinois
Sept. 6-16

THE MACHINE TOOL EXPOSITION – 1960

For information write to

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION
2139 Wisconsin Avenue, N.W. • Washington, D. C.

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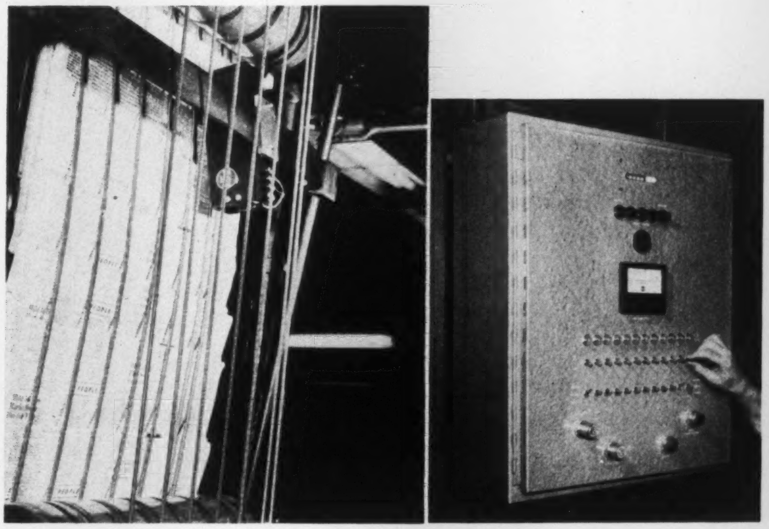
western trends

By PATT PATTERSON
Los Angeles, Calif.



NEWSPAPER counter system installed at *The Detroit News* provides a precise accounting of each edition and eliminates costly overruns or premature press shutdowns. Electrical switches, installed on 11 different conveyors carrying newspapers from the press room, sense the folded edge of each paper and relay counting signals to a remote master totalizer (right). The totalizer houses eleven input devices, one for each conveyor, together with memory and dividing systems, an electromechanical counter and visible recording dial, and controls to enable the production staff to dial the required quantity of each edition. As soon as the preset number of copies of an edition has been recorded, a signal is sent automatically to the press room superintendent to shut down the presses. The transistorized counting system was developed by Radio Corp. of America and is capable of counting up to 120,000 units a minute.

Speed Demands Control

RISING production costs seem almost as inevitable as death and taxes. Increasing costs for materials, labor, and equipment must be constantly balanced against the product selling price in order to maintain product competitiveness in a tight consumer's market. One of the best tools for maintaining this balance is automation.

This is particularly true in the printing industry. Over the past ten years many daily newspapers have either merged with competitors or gone out of business due to the inability to stay ahead of rising production costs. The surviving newspapers are applying automatic techniques throughout the printing plant. High speed press installations that accept paper in roll form and produce completely printed, trimmed, folded, and bundled newspapers have been in use in the printing industry for a long time. However, as the speed of these installations has been increased, new techniques have had to be developed to control various functions of the line.

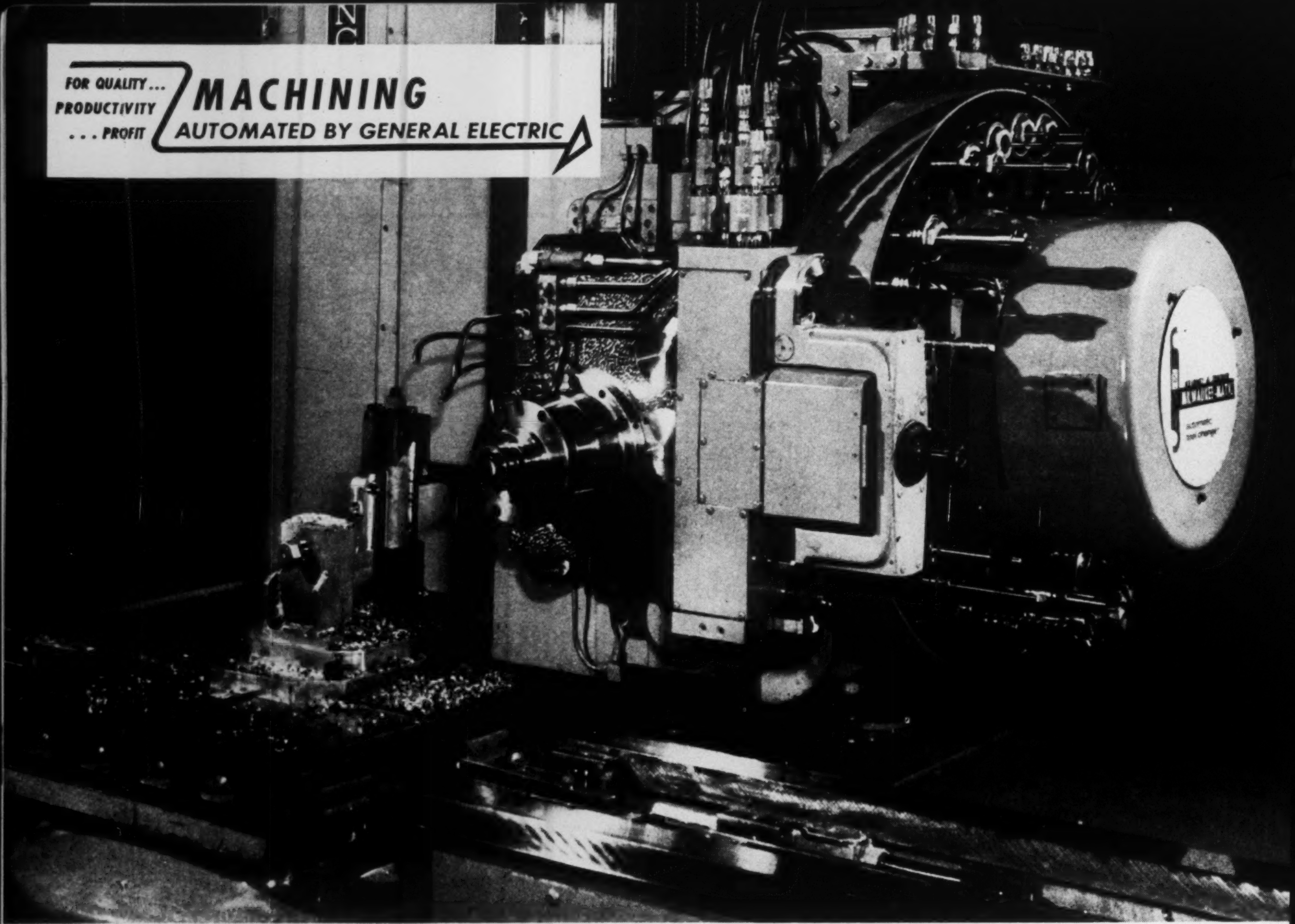
For example, when presses were running at slower speeds, printing consistency could be checked by pulling a paper off the bundling line, visually inspecting individual sheets, and then manually adjusting inking fountains. If this technique were used on today's high speed presses, hundreds of newspapers would be printed and scrapped before ink adjustments could be made. This task is now being accomplished automatically by a special electronic scanning mechanism which checks the density of the inked image on papers passing at hundreds of feet per minute beneath its lens, and then controls the roller inking to maintain consistent printing. It requires an accurate, high speed sensing device which can provide feedback control to the press to react rapidly enough to prevent loss.

While high speed presses have long been used for newspapers and large circulation magazines, automation has been slow to reach into other departments of publishing. A recent breakthrough, however, has come with the development of a tape-controlled typesetting machine.

Developed by Dow Jones & Co. Inc., publishers of *The Wall Street Journal*, an electromechanical typesetter has been in operation in its San Francisco plant for almost six years. This machine has now been improved and has been turned over to the Radio Corp. of America for production and sale to other users.

The original version of the device was a special keyboard cover which covered the keyboard of either Linotype or Intertype machines. The cover contained plungers which corresponded to the keys of the machine. As a paper tape was fed through a sensing mechanism, impulses were sent to the plungers, and the keys were depressed.

In the new version of the typesetter, called the Electro-Typesetter, there are no keyboard actuators. All control is accomplished directly at the machine's magazine with a solenoid arrangement. The principle of punched paper tape is still used,



FOR QUALITY...
PRODUCTIVITY
... PROFIT

MACHINING
AUTOMATED BY GENERAL ELECTRIC

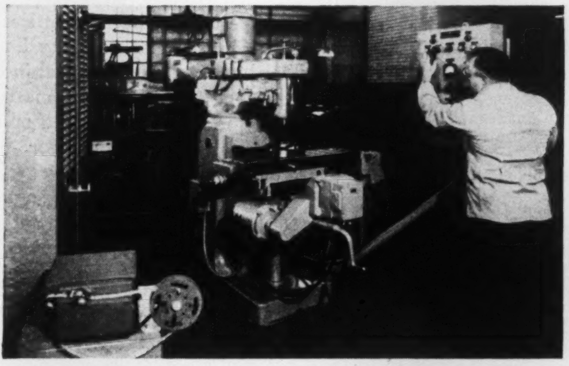
ELIMINATE SPECIAL TOOLING COST

MARK SERIES NUMERICAL CONTROLS... ...... standard, job-proved packages now in use on a wide variety of machines

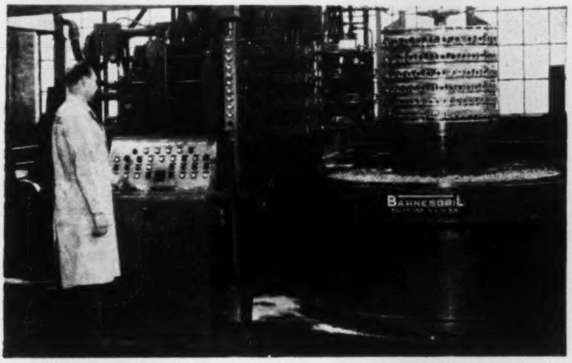
General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions — are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.



60-80% LESS FIXTURE COST is average for all new parts produced on this general-purpose milling machine. Tooling expense saving for one part totaled $2000.



TOOLING EXPENSE CUT from $5000 to less than $100; 248 critical holes spotfaced, drilled, bored, counter bored, and chamfered with no jigs or templates.

NO JIGS ARE NEEDED on this G-E controlled layout drilling machine. Tooling cost on one part was reduced from $1350 to $20; $1000 worth of fixtures eliminated on another job.

with General Electric numerical control

Eliminate jigs, cut lead times, save costly tool storage space

A key benefit of General Electric numerically controlled machines is the elimination of special tooling cost in application after application. Reports show jigs, templates, and complex fixtures are absolutely unnecessary—being replaced even in the most intricate jobs by simple holding clamps.

What does this mean to you? It's the end of costly tooling . . . it's shorter lead-time cycles . . . less investment in tool storage and maintenance . . . more flexibility in production scheduling.

Many manufacturers find that savings on tooling costs *alone* will pay for their G-E numerically controlled machines. As an example, on a group of six parts, with a variety of operations performed by a multi-purpose tape controlled machine, tooling savings totaled over $10,000 with cost reductions on a single part from $1890 to $260. With less than 100 such parts, the machine is paid for.

In a routine drilling job, $1300 worth of jigs were replaced with a simple $20 holding clamp.

And, another Mark II controlled drill press more than paid for itself in a few weeks. More than 120 different drill jigs—which would have cost $186,000 —were *not* made. These savings alone totaled more than 6 times the original investment in the numerically controlled machine!

Join with the more than a hundred manufacturers who are increasing worker productivity, gaining better product quality, and eliminating special tooling cost with G-E numerically controlled machines. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va.

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GENERAL ELECTRIC

Circle 687 on Page 19

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and this tape is read by mechanical "fingers." There is no necessity for a keyboard cover, and the machine can either be operated automatically from the tape, or may be operated manually by an operator.

Purpose of the device's development was to speed typesetting and to cut down lost time when a linotype operator was not provided with copy for setting. The paper tape is prepared by a typewriter, and can be punched at any time. Because of the inherent slowness of a typesetting machine's operation, preparation of the punched tape is much faster than manually operating a typesetting keyboard. Typesetting can be speeded up to almost three times that obtainable with manual operators.

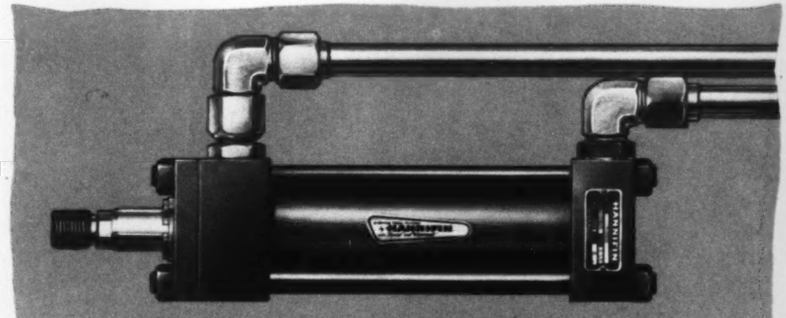
Assessing Tape Control

While a great deal has been written on the how and what of tape control for machine tools, nowhere have the advantages been realized more than in the aircraft and missile industry on the West Coast. Western aircraft manufacturers were among the first to realize the potential of numerical control, and some of them (notably Hughes Aircraft Co.) have gone into the manufacture of their own designs in this rapidly advancing field. The need for the precise control and uniformity of numerical control arises from the complexity and intricate designs of modern aircraft and missiles.

Some of the major gains attributed to numerical control are summed up by engineers at Martin Co. They feel that they have cut machine idle time sharply, have eliminated operator error, reduced setup and positioning time, and are able to study and refine control data which is not affected by human factors.

At Convair's San Diego operation, the company reports operating costs of approximately one-eighth of the costs of its former "template" methods. It also has found that numerical control is no more costly than template "tracing" or follower machinery. **A. W. Morgan,** assistant manager of operations, looks forward to ultimate costs of less than one-twentieth of the costs of manual methods when the plant has thoroughly explored all numerical control possibilities.

PARKER-HANNIFIN FLUID SYSTEM COMPONENTS



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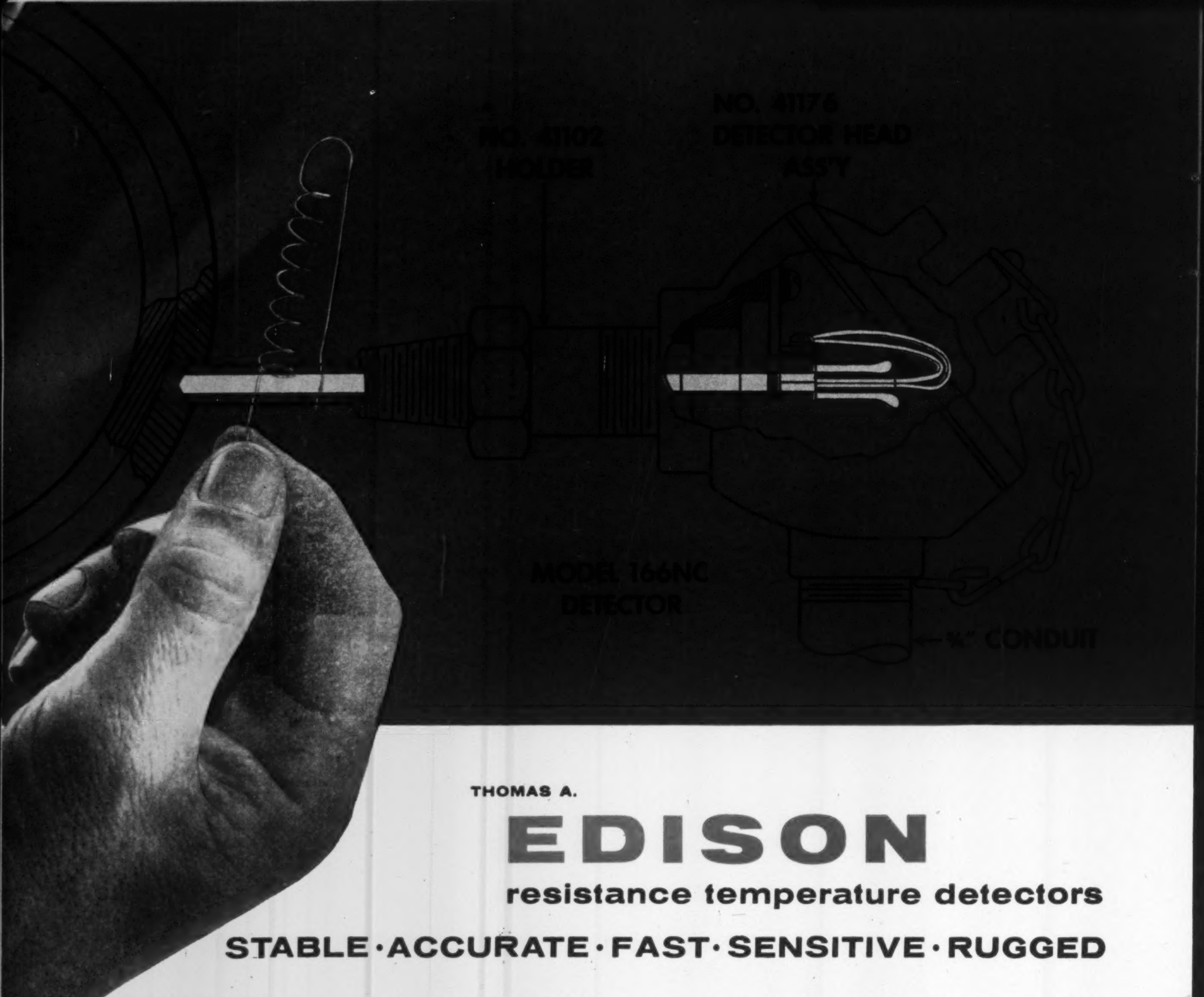

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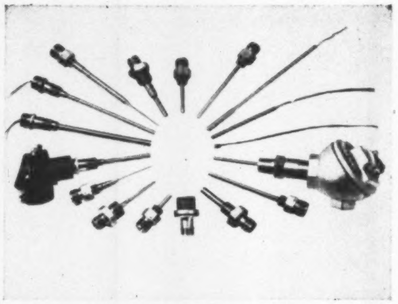

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Circle 691 on Page 19

Crossbreeding

One rather interesting phenomenon still prevalent today is the old "but our industry is different" theme. Whether it is processing equipment, handling devices, controls, data processing, or in fact any phase of the integrated systems approach, the impression that "we're different" persists.

Typical attitude in many instances is revealed by the comment that, ". . . moves to raise this level of operation must await development of the necessary sensing and control devices. Although a faster, more automatic system would solve the problem, the cost of developing these devices is prohibitive at present. . . ."

In this climate there apparently prevails an idea that suitable techniques, equipment, and devices must always be developed specially for any particular industry installation. With a heady NIH atmosphere, practical advances are delayed or passed up because such detail development is expensive, time consuming, and uncertain of success.

A little investigation will reveal plenty of good examples to show that this assumption is inaccurate to say the least. The tremendous array of devices available and already proved in service can be employed effectively regardless of the industry involved. Few industries prove to have problems entirely different or special, and for economy's sake the possibility of calling into service equipment and methods developed in other industries should never be overlooked.

To this end again this month AUTOMATION cosponsors the Fourth Conference on Manufacturing Automation at Purdue University. Outstanding authorities from many industries will discuss in open forum and off-the-record meetings a wide variety of important automation problems.

Most significant at these meetings for key executives in industry is the opportunity to crossbreed practical ideas basic to effective solution of manufacturing problems—most revealing is the fact that these problems vary little in fundamentals.

EDITOR

As experience has been gained with numerical control, improved techniques have evolved. A major effort has been made to improve the process planning that precedes the use of numerically controlled machine tools. In this article, the author highlights a variety of instances where process economy can be obtained and more effective utilization of equipment realized.

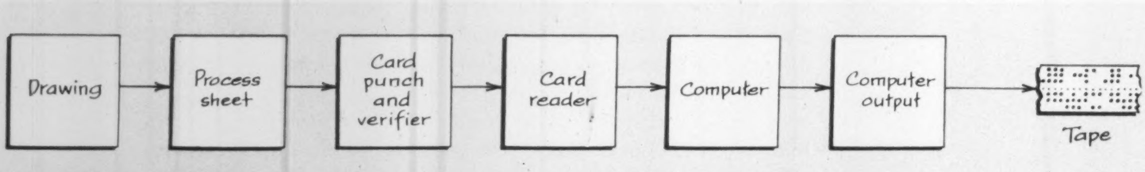
By D. R. CLANAHAN
Industrial Controls Section
Bendix Aviation Corp.
Detroit, Mich.

PROCESS PROGRAMMING

FOR TAPE

MODERN numerical control systems for machine tools offer many proved advantages in the production of complex parts. When compared with conventional machining methods, numerical controls reduce lead time, tooling costs, setup time, and machining time. To make numerically controlled manufacturing operations even more efficient, less time-consuming, and less costly, there are a number of shortcuts which can be developed and specified by the process planner during part programming operations.

Utilizing these shortcuts enables the process planner to realize more fully the potentials of numerical control. These shortcuts result from creative thinking on the part of the process planner as well as from time-saving features built into the numerical control system.



THE BENDIX SYSTEM

WITH the Bendix system a process sheet is first prepared from a part drawing, or in some cases, from a mathematical description of the part. The process sheet lists the required co-ordinate dimensions of the part in the desired cutting sequence, along with such information as machine feed rates, cutter diameters, and machining tolerances.

The information on the process sheet is placed in coded and condensed form (suitable as input information to a computer) on punched cards or a punched process tape. This is accomplished by typing the process sheet on special typing machines which will simultaneously prepare punched cards or tape. The cards or process tape are verified by a reader unit attached to the special typing machine.

The condensed information on the verified cards or process tape is fed to a computer by a computer input reader. The computer reads this information and calculates cutter center loci, interpolates curve sections to provide intermediate points defining a continuous cutter path, translates decimal input information into binary coded form, and punches this code on plastic machine control tape.

The interpolation function performed by the computer establishes the required spacing of the intermediate points on curved sections in accordance with the tolerances specified on the process sheet.

Since the cutter path between the sequential points will be along a straight line, the spacing of points will vary so that the deviation from the desired curve will always be sufficiently small to satisfy the tolerance and surface finish requirements.

SHORTCUTS

CONTROLLED MACHINES

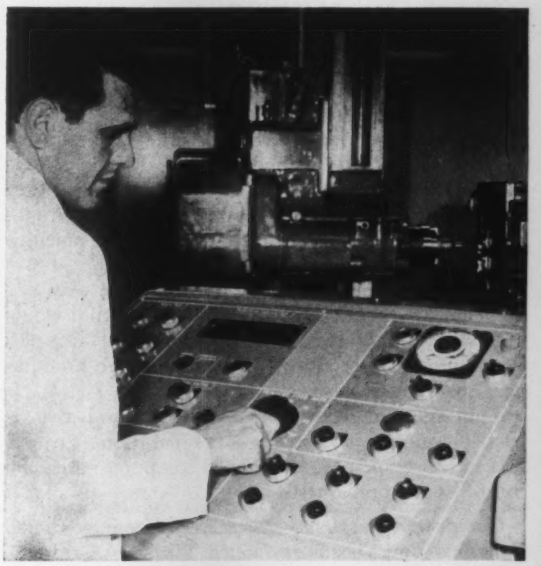
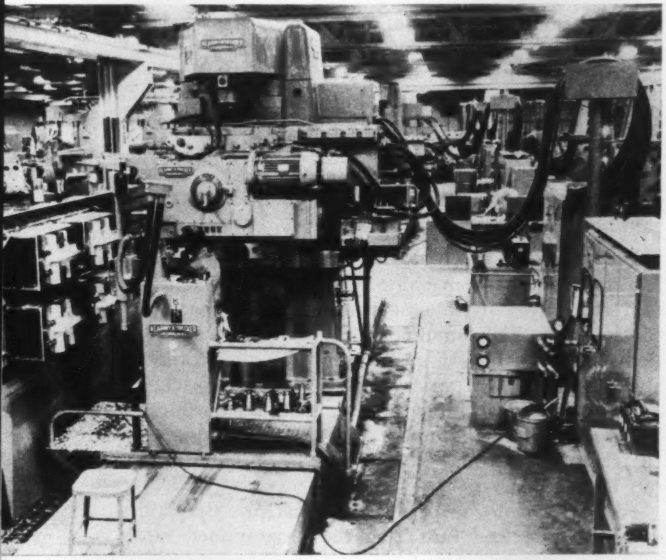


Fig. 1—Operator is shown making adjustment on control console to obtain a feed rate that differs from the programmed feed rate. The override feed rate is set as a per cent of the programmed feed rate.

▶ Areas of Process Economy

There are seven areas in numerical control part programming and part machining where creative thinking and programming can develop shortcuts, or built-in shortcut features can be used to reduce the cost of a machined part. These areas are: 1. Planning. 2. Process sheet or manuscript preparation. 3. Card or process tape preparation. 4. Computer time. 5. Machine time. 6. Tooling cost. 7. Part handling cost.

In any numerical control machining operation, a study of all of the above areas should be made to determine where shortcuts can be made so that most economical part programming and machining operations can be accomplished. Shortcuts will reduce some operations in the over-all process of programming and machining of a part by numerical control methods. In a few cases, shortcuts will reduce part programming time but will increase machining or handling time. In some other cases, machining or handling time are reduced but programming time is increased. In general, a decrease in programming time is advantageous on short runs or in cases where one-of-a-kind parts will be produced. A decrease in machining or handling time is usually advantageous where a large number of parts are to be machined by numerical control methods.



It will be up to the part programmer to decide where and how shortcuts can be made and whether or not a decrease in programming time will offset an increase in machining time and conversely.

Where applicable, built-in time saving features in the numerical control system will always be advantageous to use, to reduce the amount of work required in programming and machining parts and thus reduce manufacturing costs.

The following two sections contain a number of examples, illustrating cost saving and shortcuts in the over-all manufacturing process. The first section will discuss the "built-in" special time saving features of numerical control and the second section will discuss some typical creative shortcuts developed by users of Bendix equipment as a guide to process planners.

▶ Built-In Savings

Symmetrical Parts. It is possible to reduce programming time for symmetrical parts, right and left

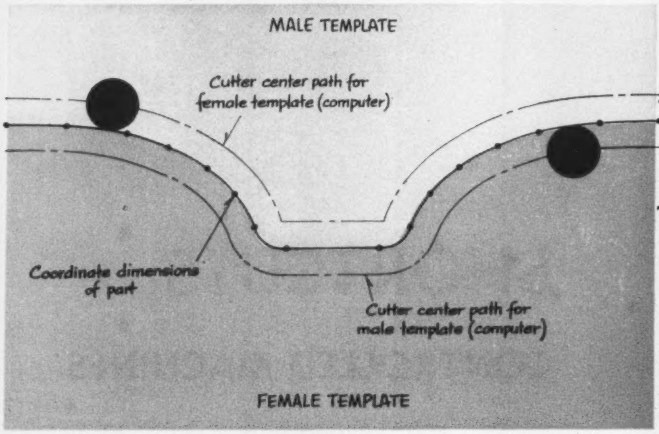

MALE TEMPLATE
Cutter center path for female template (computer)
Coordinate dimensions of part
Cutter center path for male template (computer)
FEMALE TEMPLATE

Fig. 2—To program a machine when both a male and female template are to be produced, it is possible to use one set of co-ordinates that describe the shape of the template. Tool center offsets for both templates are calculated from the same basic data.

hand parts, and parts with the same configuration on both sides. For example, in the Bendix system a reversing circuit is provided in the numerical control system for each machine tool axis. The circuits will complement or reverse the direction of machine motion to that programmed on the tape.

A part symmetrical about one or more axes can be made with 1/2 to 1/4 the length of tape that would otherwise be required. Only one quadrant of a part symmetrical about the *X* and *Y* axes, for example, need be programmed.

This shortcut feature reduces time and cost of part planning, process sheet preparation, card or process tape preparation, and computer time for control tape preparation.

Computer Programs. Machine control computer programs have been developed for several general purpose computers (including Bendix G-15-D and IBM 650, 704, 705, and 7090) to reduce the time and cost of part programming. With computer programs only a minimum amount of data need be supplied to the computer to obtain a control tape.

For example, for a straight line only the co-ordinates of the two end points are required. For circular arcs, only radii and end points of arcs need be specified.

One computer program (Compac-01 for Bendix G-15-D computer) will automatically prepare control tapes for two-dimensional contour milling of parts composed of straight lines and circles and profiling or turning of essentially two dimensional parts. This routine will also prepare control tape for completely milling out pocket areas bounded by straight lines and circular arcs. For a square pocket, only four points need be programmed. The pocket milling program will automatically compute the paths of the cuts in similar-shaped and expanding patterns until the final desired boundary is reached. The only data required is the pocket setup information and definition of the pocket boundary.

Another computer program, called Compac-02, will automatically fit curves through a sequence of points and prepare control tapes for the numerically controlled machining of such free-form curves. An adaptation of this computer program will automatically prepare control tape for the numerically controlled profiling or turning of two dimensional free-form shapes.

Computer Programming. The computer can be used for difficult part programming operations where automatic machine tool computer programs are not available. By passing problems through the computer as a preliminary operation it might be possible to generate point information required for the automatic machine tool program, reducing design, planning, and process sheet preparation time.

The computer might be used to provide part design information from manufacturing information or performance data. Computed design information might then be fed back into the computer which in turn would prepare a control tape to machine the part contour. For example, a cam contour can be programmed and punched on tape by the computer from the cam performance data. In this case, it is conceivable that the designer may never see the shape of the cam until it is produced by the numerically controlled machine tool.

In many instances, all that might be required to produce a part, when using the computer for actual design calculations, will be the formulas defining the part contour. For example, a cam whose entire profile can be defined by formulas requires no complicated part drawing. The formulas could be simply fed to the computer which, in turn, could provide a control tape to control the machine tool in the manufacture of the cam.

Programming machining sequence is an important factor to minimize the nonmachining portion of a cycle. In other words, machining sequences should be programmed so that the tool will have minimum "air" travel from one machining surface to another. This is a difficult problem to solve and will vary for each different part shape. Hours could be spent manually calculating the best machining sequence. The computer might be used to optimize the machining cycle.

Feed Rate. A manual feed rate override feature, *Fig.* 1, permits the machine operator to vary cutter feed rates from those programmed on the machine control tape. This eliminates reprogramming operations, additional card or process tape preparation, and computer time to provide a new feed rate when variables such as cutter quality, material hardness, or vibration from fixture or tool cannot adequately be taken into account at the time the original feed rate is programmed.

Feed rate override permits the machine operator to reduce the feed rate from the programmed rate down to as little as 20 per cent of the programmed rate. Feed rate override may be exercised at any time during the machining cycle. With the proper feed rate, the tool will be correctly loaded at all times. This will result in maximum production rates and the best possible surface finish.

▶ Creative Data Processing

Cutter Offset. A cutter offset programming shortcut, *Fig.* 2, will reduce process sheet preparation and card or process tape punching operations when preparing control tape for machining male and female parts, such as templates, where the male template will be used for tracer machining operations and the female template would be used for inspection of the parts produced from the male template.

When machining male and female templates, the co-ordinate dimensions for each template will be exactly the same. The one set of co-ordinate dimensions is listed on the process sheet and tool center offsets are called for in two directions, one for the male and one for the female part. A set of cards is punched for input to the computer with the cutter offset for the male part. This information is then fed to the computer and a control tape is produced for the male template.

To produce a control tape for the female part, all that is required is the changing of the tool center offset on a few cards and feeding this new information to the computer. The computer will produce a control tape for automatically controlling the machining operations on the female template.

With this method, minimum process sheet preparation and card punching are required. Without realizing that this type shortcut can be used, the process planner might prepare two process sheets, one for each template, and perform two complete card punching operations.

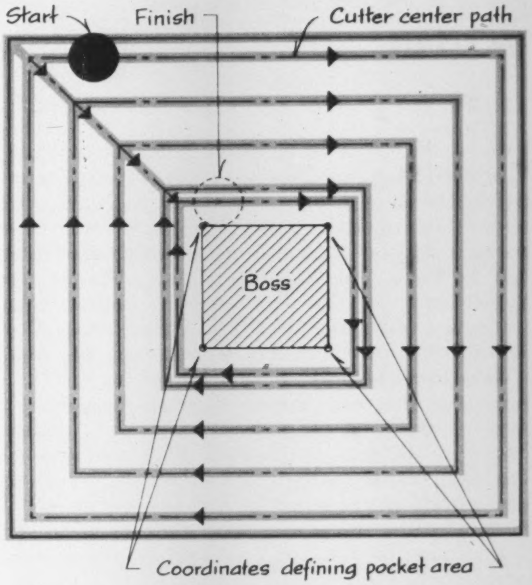


Fig. 4—Computers can be preprogrammed to store routines for easier handling of a variety of recurring problems. Such routines enable a programmer to obtain a control tape by specifying only a minimum of information about certain key points. With a pocket milling routine, the illustrated boss on a flat surface could be programmed with only eight entries on the process sheet, in comparison to 30 or 40 that might be required if a routine were not used.

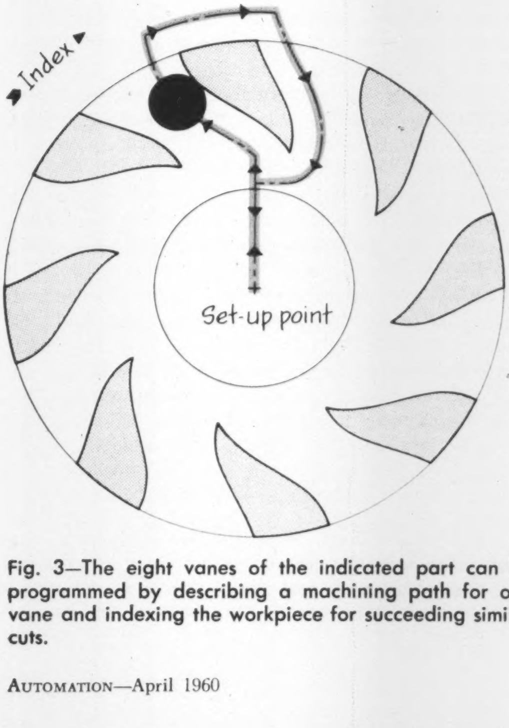


Fig. 3—The eight vanes of the indicated part can be programmed by describing a machining path for one vane and indexing the workpiece for succeeding similar cuts.

Indexing Repetitive Parts. Programming time can be substantially reduced on parts which have a number of repetitive contours to be machined by numerical control methods. This is accomplished by programming the contour just once and indexing the part and rewinding the control tape.

For example, in machining a diffuser ring containing eight vanes of identical contour, *Fig.* 3, a great deal of programming time could be saved if only one vane were programmed and the part indexed on the machine tool eight times. In this case, computer, manuscript, and card punching times would be reduced.

With the indexing method, machining time would be slightly increased to allow for manual indexing operations and recycling the tape to starting position after each index.

The time, cost, and possible operator error for indexing should be compared with time and cost of eight computer runs to find the most time-saving and economical production method.

Pocket Milling Inversion. Pocket milling routines, as previously described, can be utilized with great programming time savings when machining flat surfaces, bosses, or other raised surfaces. For example, if a part having a flat face, with a boss located on the flat face of the part, is to be machined, *Fig.* 4, the area around the boss can be treated as a pocket and the automatic pocket milling routine can be used. Only the co-ordinates defining the pocket area and setup points are required. The computer will automatically calculate machining operations to machine the flat face and the boss.

This shortcut method greatly reduces precomputer planning time, process sheet preparation, and card or process tape preparation. With a square boss on a flat face, for example, all that is required are eight entries on the process sheet. If this shortcut method were not used, 30 or 40 entries would be required on the process sheet with a corresponding increase in time spent on card or process tape preparation.

Surface Finish. One area where the time and cost of programming can be greatly reduced is that of surface finish requirements. In many instances, it is assumed that numerical control will automatically provide a high surface finish without any extra cost. However, it is costly to program for a high surface finish, and this should not be done if the part is to have an additional finishing operation. The finer the surface finish required, *Fig.* 5, the more passes required by the cutter and the more planning, process sheet preparation, card or tape punching, computing time, and machining time required.

For example, to machine a 0.0002-inch scallop height on a particular complex part, a control tape may cost $800. To machine a 0.0032-inch scallop height, the tape may cost only $200. Assume it might take 2 hours to hand grind or barber a workpiece having 0.0002-inch cusp heights and 14 hours to hand finish a 0.0032-inch cusp height. Relatively expensive computer time is reduced by a factor of four. Machine time and processing time may also be reduced by a factor of four. Relatively inexpensive hand barbering time is increased by a factor of seven. The total cost may be reduced sufficiently by opening the scallop height tolerance.

It should be remembered that numerical control can provide extremely high surface finishes, and this advantage should be used when required. However, it should also be remembered that a man may be able to hand finish at a lower cost than finishing can be done with numerical control methods. If a surface is hand-ground to the valley of the cut made by the numerically controlled milling cutter, a fairly accurate contour and satisfactory surface finish will result.

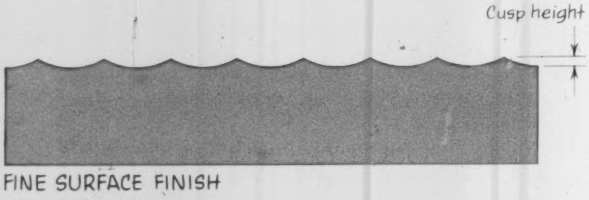
Part Handling. Part cost might be reduced if all machining operations are programmed for numerical control. It is costly to partially machine a complicated part by numerical control methods and then transfer the part to another machine to perform some of the less complicated machining operations.

For example, it is expensive to completely machine the surface of a complicated casting and then take the extra time to manually transfer the part to a drill press to drill three holes. The hole drilling operation might best be programmed for numerical control machining. The cost for programming the hole drilling operations would be small compared to the cost of handling the part during the machine change and designing and making a fixture for the hole drilling operation.

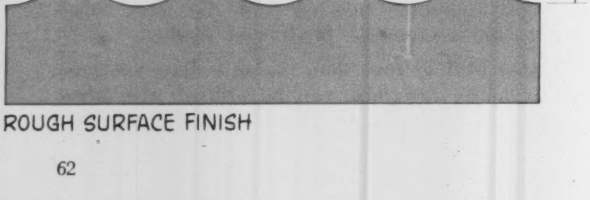
Rough and Finish Cuts. When machining a part contour requiring rough and finish cutting operations there are three shortcuts that can be employed to save programming, machining, tooling, and handling time.

First, the outline of the part could be treated as a negative pocket and the automatic pocket milling inversion routine, previously described, could be used to program the rough and finish cuts. Only the set-up information and the definition of the boundary need be programmed. This routine will automatically compute the path of the rough and finish cuts until the desired part contour outline is obtained.

With the second method, the part contour is programmed only once and cutters of increasing size are used for each rough cut and the finish cut, *Fig.* 6. For example, assume a part is to be machined by numerical control methods and the part requires two rough cuts of ⅛ inch and one finish cut of 1/16 inch. One not familiar with numerical control shortcut methods would assume that the part contour would be programmed with three passes with one cutter diameter. However, the



FINE SURFACE FINISH



ROUGH SURFACE FINISH

Fig. 5—A fine surface finish can be obtained at the expense of repeated passes by the cutter. Programming and machining time might be saved if certain surface finish requirements are obtained by manual operations.

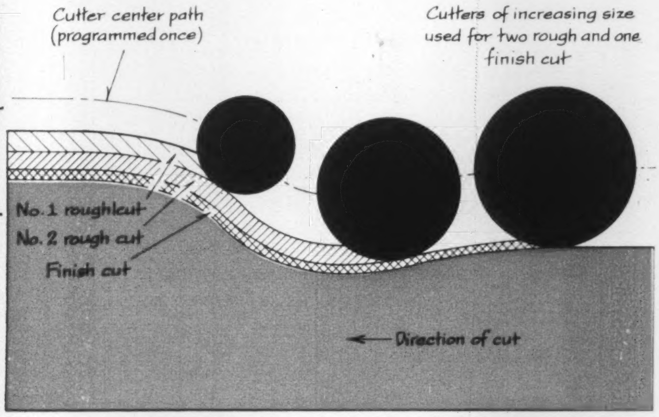

Cutter center path (programmed once)
Cutters of increasing size used for two rough and one finish cut
No. 1 rough cut
No. 2 rough cut
Finish cut
Direction of cut

Fig. 6—Where a combination of rough and finish cuts is required, it is possible to compute one cutter center path and direct cutters with successively larger diameters over the single path. One computer run is required, but tools must be changed.

computer determines the tool center path from the cutter size. Therefore, by programming the part once for a 2-inch cutter and then using a $1\frac{5}{8}$-inch cutter for the first rough cut, a $1\frac{7}{8}$-inch cutter for the second rough cut, and a 2-inch cutter for the finish cut operation, processing time and cost may be reduced by a factor of two-thirds. This method eliminates extra planning, manuscript writing, card or process tape preparation, and computer time.

With the third method, the same tool diameter is used for rough and finish cutting operations, but rough and finish cutter paths are programmed for different size cutter diameters, *Fig.* 7. To perform one rough cut and one finish cut, the rough cut path for a $1\frac{1}{8}$-inch cutter, for example, is programmed. Then by changing the cutter diameter on a few cards or the process tape, to say a 1-inch cutter diameter, the computer will punch a new cutter path for the 1-inch cutter. However, the $1\frac{1}{8}$-inch cutter is never used. The 1-inch cutter follows the programmed path for the $1\frac{1}{8}$-inch cutter making the rough cut and the 1-inch path for the finish cut. This method saves planning, manuscript writing, card or tape preparation, and machining time because only one process sheet is prepared, one card or tape punching operation is required, and tool changes are eliminated. Two computer runs are required, however, to program the cutter center path for the rough cut and finish cut. In evaluating the single tool or multitool methods, the additional computer time and cost in using a single tool should be compared with tool change time and cost in using several tools to determine which is more economical.

Process Sheet. The process sheet should be properly designed to simplify the programming operation and flexible enough to cover a wide range of parts. The Bendix Compac-01 process sheet is designed so that it can be used easily to program any part composed of straight lines, circles, pockets, and free-form curves for machining on a profile milling machine.

Special process sheets for particular types of applications are feasible. For instance, to simplify process planning, Bendix has recently developed two new process sheets. One is specifically designed for programming parts which are bodies of revolution and are machined on numerically controlled turning or boring machines. The other process sheet is designed for the easy programming of templates. These specialized sheets are designed to simplify programming operations but flexible enough to cover all parts falling under these machining categories.

With correctly designed and flexible process sheets, the reference points can be changed from those on the part drawing to correspond with the part as fixtured on the machine. This simplifies part programming in instances where the part is to be fixtured on the machine in a different position than shown on the drawing. This makes tool path programming much easier.

Part Drawing. It is useful in data processing to have all dimensions given from a set of fixed coordinates. It is desirable to make a table of dimensions from the part drawing to reduce the possibility of error in transferring numerical data to the process sheet. As a part planner becomes more experienced, he will find it more efficient to provide a table of dimensions rather than place the dimensions on the part drawing.

Terms. The terms used on the process sheet for programming should be terms that are easily understood and already familiar to process planners. The Bendix system uses terms covered in high school mathematics. With this method, it is far easier to train future process planners because a

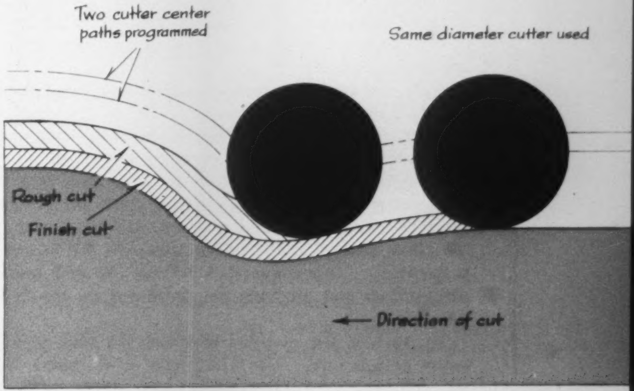
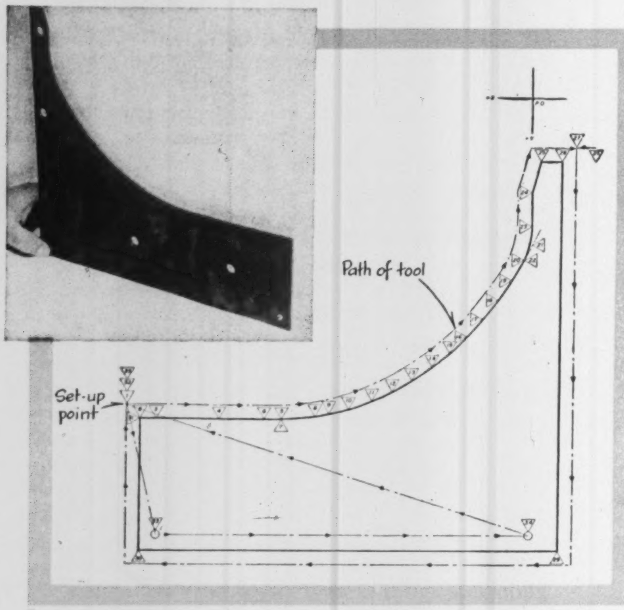
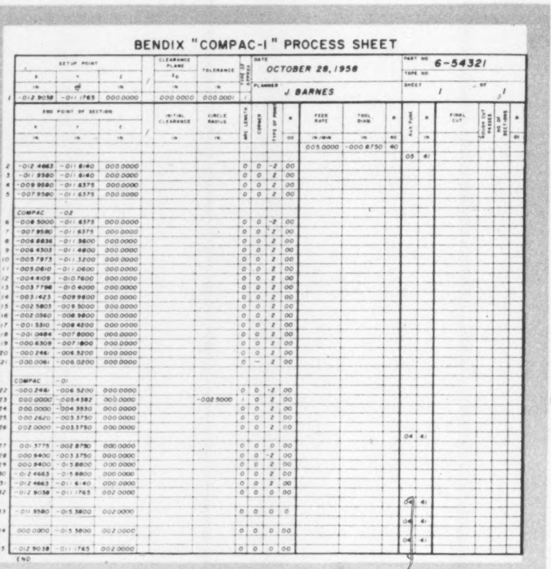


Fig. 7—If the same diameter cutter is to be used for a rough and finish cut, basic co-ordinate data can be applied to calculating two different center paths. The rough cut is computed as if a larger diameter cutter were to be used, and the finish cut for the actual diameter of the cutter. Two computer runs are required.





BENDIX "COMPAC-I" PROCESS SHEET

	SETUP POINT			/	CLEARANCE PLANE	TOLERANCE	TYPE OF APPROX
	X	Y	Z		Z_0		
	IN	IN	IN		IN	IN	
1	-012 9038	-011 1765	000 0000		000 0000	000 0001	1

DATE OCTOBER 28, 1958
PLANNER J BARNES
PART NO 6-54321
TAPE NO
SHEET 1 OF 1

	END POINT OF SECTION			/	INITIAL CLEARANCE	CIRCLE RADIUS	ARC LENGTH	CORNER	TYPE OF POINT	R	FEED RATE	TOOL DIAM	R	AUX FUNC	R	FINAL CUT	ROUGH CUT PASSES	NO OF SECTIONS	R
	X	Y	Z																
	IN	IN	IN		IN	IN				00	IN/MIN	IN	40		41				01
											005 0000	-000 8750	40						
														05	41				
2	-012 4663	-011 6140	000 0000				0	0	-2	00									
3	-011 9580	-011 6140	000 0000				0	0	2	00									
4	-009 9580	-011 6375	000 0000				0	0	2	00									
5	-007 9580	-011 6375	000 0000				0	0	2	00									
	COMPAC	-02																	
6	-008 5000	-011 6375	000 0000				0	0	-2	00									
7	-007 9580	-011 6375	000 0000				0	0	2	00									
8	-006 8836	-011 5600	000 0000				0	0	2	00									
9	-006 4303	-011 4800	000 0000				0	0	2	00									
10	-005 7973	-011 3200	000 0000				0	0	2	00									
11	-005 0610	-011 0600	000 0000				0	0	2	00									
12	-004 4109	-010 7600	000 0000				0	0	2	00									
13	-003 7798	-010 4000	000 0000				0	0	2	00									
14	-003 1423	-009 9600	000 0000				0	0	2	00									
15	-002 5803	-009 5000	000 0000				0	0	2	00									
16	-002 0560	-008 9800	000 0000				0	0	2	00									
17	-001 5310	-008 4200	000 0000				0	0	2	00									
18	-001 0484	-007 8000	000 0000				0	0	2	00									
19	-000 6309	-007 1800	000 0000				0	0	2	00									
20	-000 2461	-006 5200	000 0000				0	0	2	00									
21	-000 0061	-006 0200	000 0000				0	—	2	00									
	COMPAC	-01																	
22	-000 2461	-006 5200	000 0000				0	0	-2	00									
23	000 0000	-005 4382	000 0000			-002 5000	1	0	2	00									
24	000 0000	-004 5530	000 0000				0	0	2	00									
25	000 2620	-003 3750	000 0000				0	0	2	00									
26	002 0000	-003 3750	000 0000				0	0	2	00									
														04	41				
27	001 3775	-002 8790	000 0000				0	0	0	00									
28	000 9400	-003 3750	000 0000				0	0	-2	00									
29	000 9400	-015 8800	000 0000				0	0	2	00									
30	-012 4663	-015 8800	000 0000				0	0	2	00									
31	-012 4663	-011 6140	000 0000				0	0	2	00									
32	-012 9038	-011 1765	002 0000				0	0	0	00									
														04	41				
33	-011 9580	-015 3800	002 0000				0	0	0	0									
														04	41				
34	000 0000	-015 3800	002 0000				0	0	0	00									
														04	41				
35	-012 9038	-011 1765	002 0000				0	0	0	00									

END

PROCESSING A TYPICAL PART

The processing of two templates has been selected to illustrate some of the factors and shortcuts to consider in the manufacturing processing or production planning. The template form is shown in the photograph.

One template is to be 0.02 inch oversize and will be used for guiding a tracer control machine in a rough cutting operation. The other template will be made to finish size and will guide a finish machining operation. Both templates require a rough and finish machining operation. Because only a few templates are to be made, it is advantageous, in this instance, to keep programming time and cost to a minimum even if machining time is somewhat increased. Therefore, the cutter change shortcut method was used in this application. With this method, only one template and one cutter path need be programmed. Three different cutter sizes are then used to machine the rough and finish cuts on both templates even though one template is undersize. This method greatly reduces planning, process sheet preparation, card or process tape preparation, and computer time.

With this method, both templates are programmed for a 0.8750-inch cutter diameter. Special instructions are given to the machine operator, on an instruction sheet, for the cutter changing. To start machining of the finish size template, a cutter diameter of 0.750 inch is first used. This cutter follows the tool center path programmed for the 0.8750-inch cutter and machines the rough cut. When the cutter returns to the set-up point, the 0.8750-inch cutter is installed. This cutter then follows the tool center path programmed and produces the finish cut on the finish size template.

To machine the oversized template, the same programmed cutter path is used. The 0.7500-inch cutter makes the rough cut following the programmed tool center path for the 0.8750-inch cutter diameter. Then a cutter with a diameter of 0.835-inch is used to make the finish cut on the curved portion of the template. This produces a template with the critical portion 0.02-inch oversize from the finish template. When the 0.835-inch diameter cutter has completed the critical part of the template form, a programmed stop automatically stops the machine. The 0.8750-inch cutter diameter is then installed and completes the machining operation for the non-critical portion of the template.

Programming

To machine the templates, straight lines, a known radius, and a curve defined only by a sequence of points are programmed. Two holes are also programmed and drilled after the template contour is machined. The template is to be machined to finished dimensions from a flat steel plate. Preparation of a process sheet is simplified if a drawing such as that shown above is prepared, and dimensions are expressed as directed distances from a set of reference axes and tabulated. The completed process sheet for this template is shown above, right.

The main portion of the process sheet is divided by double ruling into four sections. The last column in each field, labeled *R* (routine identification number), is used to indicate what kind of information has been entered. Dimensional information in the lefthand field is identified by 00 *R* number, tooling information in the center of the sheet is identified by a 40 *R* number. An *Auxiliary Function* code is tagged with a 41 *R* number, and the righthand field, which is used only in pocket milling, is identified by an *R* number of 01.

Point 1 is the tool setup point and the co-ordinates of this point are entered at the top left of the sheet. A value for Z_o (daylight clearance), at which any desired motion of the other two axes (*X* and *Y*) can be made with no danger of interference with the workpiece or fixture, is determined and entered in the next position labeled *Clearance Plane*.

The tolerance to be allowed when approximating a curve by straight lines is the next entry. In this instance, a tolerance of 0.0001 inch is used. The entry of 1 in the *Type of Approximation* column indicates that curves will be approximated by chords.

The feed rate and the tool diameter to be used in the completely new language does not have to be learned.

Instruction Sheet. In addition to a process sheet, the process planner should prepare an instruction sheet for the machine operator. This sheet should contain detailed information and instructions for mounting the workpiece on the machine tool, a description of the tool or tools to be used and how they are to be used, and details of the proper set-up position of the tool. This not only aids the machine operator but also minimizes time-consuming rechecking and mistakes.

The application of some of these shortcut methods to a typical problem is illustrated in a box accompanying this article ("Processing a Typical Part"). In one sense, the word "shortcut," as applied to the points covered by this article, is inappropriate since it implies a sort of clever deviation from normal. But in industry the normal should be the most efficient way. In reality, then, the article refers to an efficient use of both a machine's capabilities and a programmer's time—and if the inherent advantages of numerical control are to be realized, both must always be used efficiently.

machining operation is then entered. The minus sign on the tool diameter indicates that the tool center will be positioned to the left of the desired cut. A plus sign causes the tool to be positioned to the right of the desired cut.

The next entry, 05, in the *Auxiliary Function* column causes the punching of a reference code in the control tape. Reference codes are ignored while tape is moving in the forward direction in the machine control unit, but will stop the tape reader if it is searching in the reverse direction. They are useful in initially positioning the tape in the tape reader of the machine control unit and in reestablishing synchronization of tape in the event of emergency shutdowns due to tool breakages, etc.

If the word *Print* were placed at the top of the main portion of the sheet, it would serve as a command to the computer to print the cutter center point corresponding to each data point on the sheet. This printed information serves as a means of monitoring the computer operation and checking the accuracy of the resulting control tape.

The co-ordinates are then entered for Point 2. A zero entered in the *Arc Length* column means that motion to this point shall be a straight line. The 2 entered in the *Type of Point* column indicates that tool center offsets shall be computed in the *XY* plane. Placing a 1 in the column would call for offsets in the XZ plane, and a 3 in this column would be for offsets in the *YZ* plane. A zero in this column means that the co-ordinates listed refer to the cutter center, and no offsets should be computed. The minus sign in this case indicates that this is the starting point of a sequence of points (Points 3, 4, and 5) requiring offset computation.

The portion of the part contour from Points 7 to 20 is a curve defined only by a sequence of points. This type of contour is easily programmed by the computer routine designated as *Compac*-02. The entry of the command *Compac*-02 causes the computer to call for information from a magnetic tape storage unit. The proper routines will be located and loaded into the computer with no assistance required from the operator. *Compac*-02 is designed so that the process planner specifies the desired slope at the first point and the last point of the curve. For this reason, tangent lines are drawn at Points 7 and 20 and Points 6 and 21 are located on these tangent extensions. Point 6 is entered as a starting point for this curve and Points 7 through 20 are then listed, followed by Point 21. The minus sign in the *Corner* column indicates that Point 21 is the final slope point of the curve.

Since the rest of the machining operations are composed only of straight lines and circles, the command *Compac*-01 is entered on the process sheet. This command causes another magnetic tape search and a reloading of the computer.

Points 22 through 26 are then listed on the process sheet. Since Points 22 and 23 are joined by a circle, the *Arc Length* column for Point 23 contains a 1, indicating a circular arc of not more than 180 degrees. Placing a 2 in the *Arc Length* column would indicate a circular arc of more than 180 degrees. The radius of the circle is entered in the appropriate column for Point 23. The fact that the radius is entered as a negative number indicates that the circle is to be traversed in a counterclockwise direction. A positive sign on the radius would indicate a clockwise traverse of the circle. The entry of zero in the *Corner* column indicates that the tool moves around the inside rather than the outside of the corners at these points.

At Point 26 a 2.00 inch dimension is listed in the *X* axis column which brings the cutter center away from the machine face of the template and the machining operation is stopped. The stop code punching results from entry of 04 in the *Auxiliary Function* column. The presence of a stop code in the control tape will cause the machine control unit to wait in idle position until the *Start* button is pushed by the operator. At this point, a cutter change is made for the oversize template. When the machine stops at this point during the machining of the regular size template, the operator merely pushes the *Start* button to continue machining operations.

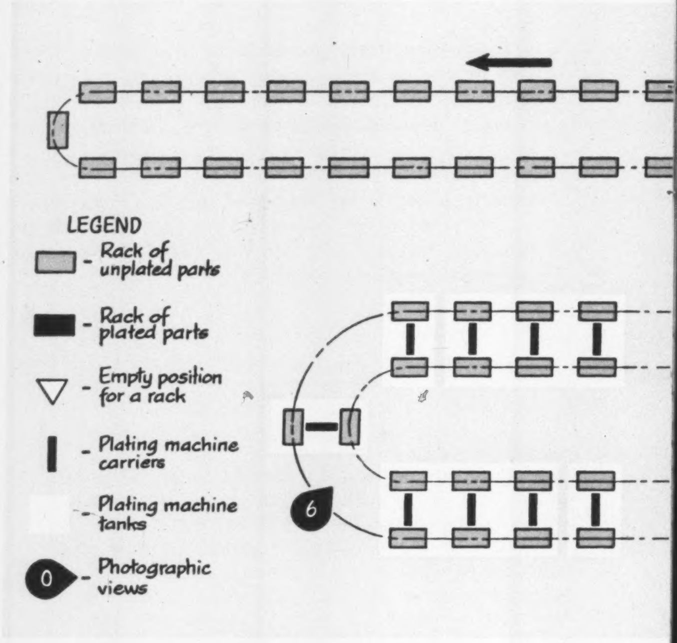
The next six lines on the process sheet contain the co-ordinates of Points 27, 28, 29, 30, 31, and 32. Since the co-ordinates of the setup point (Point 32) refer to the tool center, no offset computation is required and accordingly a zero is entered in the *Type of Point* column. A stop code is then entered on the next line in the *Auxiliary Function* column. At this point, another cutter change is made for drilling the two holes in the template.

The next two lines on the process sheet contain the co-ordinates for the two drilled holes. The last line calls for a return to set-up point in the *XY* plane, followed by the word *End*. The command *End* signals the computer that the problem is finished. This causes the punching of the last block of motion information on the tape.

It can be readily seen how the use of simple language greatly simplifies part programming operations. After completion of the process sheet, the remaining phases of tape preparation can be done by a typist and a computer operator. All information necessary for the automatic machining of the part is now available for routine processing—first by the computer, and later by the machine control unit during actual machining operations.

1

Plan view indicates layout of system to plate more than 100 different parts with intermixed selections of three different plating cycles. No changeover is required; an operator merely sets a flag device for each rack of parts on the 56-station monorail. Racks are automatically transferred to and from the 46 carriers on the plating machine, where each carrier on the plating machine carries two racks through the selected plating cycle. Racks of plated parts normally come from the plating machine at the rate of 144 racks per hour.


LEGEND
▭ - Rack of unplated parts
■ - Rack of plated parts
▽ - Empty position for a rack
▌ - Plating machine carriers
- Plating machine tanks
0 - Photographic views
6

AUTOMATION TODAY

PLATING WITH SELECTIVE HANDLING

HANDLING is an especially important part of operations in a plating facility. As a result, solutions to some handling problems may be more advanced in plating facilities than in many other manufacturing plants. An interesting example is an installation at Broadway Chromium Plating Co., Brooklyn, N. Y. This firm supplies tubular components for dinette sets, occasional furniture, and baby carriages. To meet today's demand and maintain its current market position, the firm is turning out more than 100 different kinds of parts and plating them to order in chrome, brass, or bronze.

Some time ago, the management of this firm discussed their production problems with the engineers at Hanson-Van Winkle-Munning Co. A solution was developed which incorporates an automatic elevator-type plating machine with a shuttle arrangement to automatically transfer racks of parts between the plating machine and a monorail conveyor.* The

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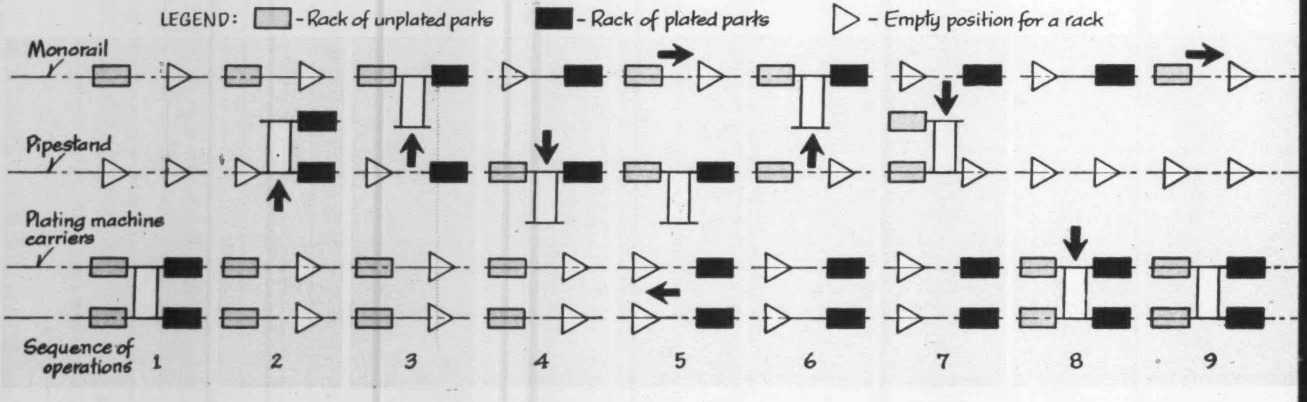
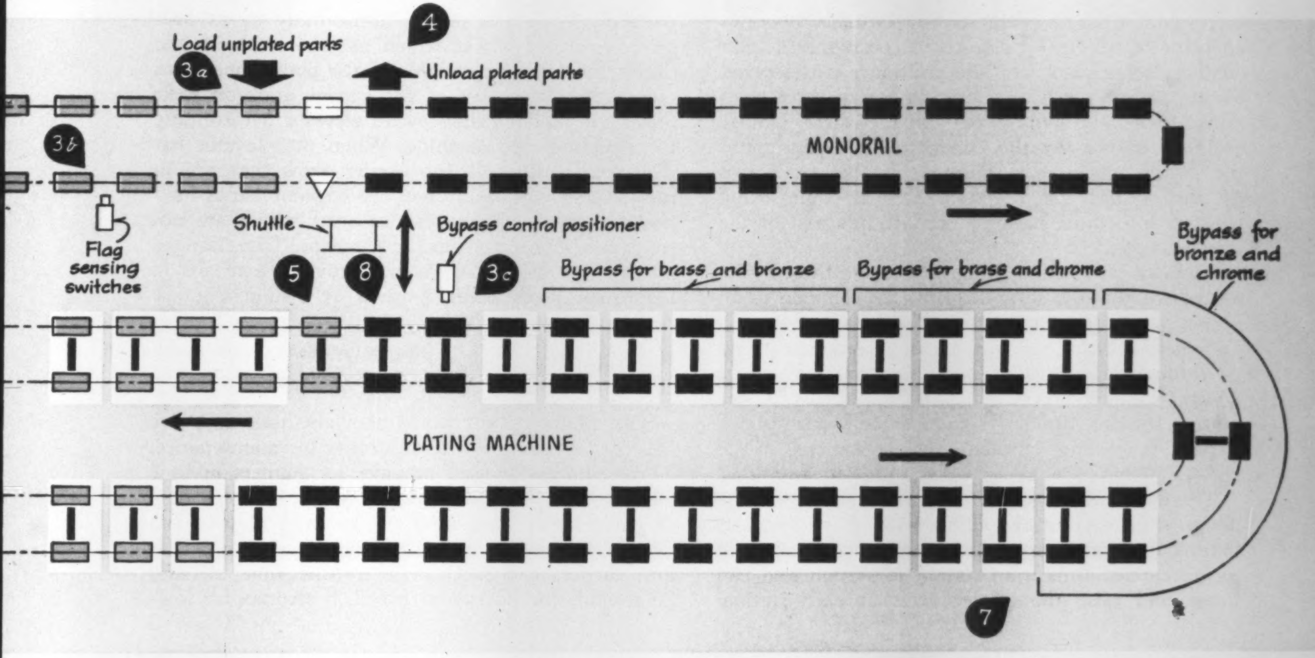
*For another solution to a similar problem, see R. L. Everstine, "Transferring Racks Automatically," AUTOMATION, Vol. 5, No. 7, July 1958, pp. 61-63.


LEGEND: ▭ - Rack of unplated parts ■ - Rack of plated parts ▷ - Empty position for a rack
Monorail
Pipestand
Plating machine carriers
Sequence of operations
1
2
3
4
5
6
7
8
9


4
Load unplated parts
3a
Unload plated parts
MONORAIL
3b
Flag sensing switches
Shuttle
Bypass control positioner
5
8
3c
Bypass for brass and bronze
Bypass for brass and chrome
Bypass for bronze and chrome
PLATING MACHINE
7

monorail conveyor brings racks of unplated parts in single file to the shuttle. This transfer device loads two racks of unplated parts on each carrier of the plating machine. The shuttle also takes racks of plated parts off the plating machine two at a time and transfers them to the monorail conveyor in single file.

The system also includes a plating cycle control which allows an operator along the monorail conveyor to select any one of three plating cycles for a given rack of parts. Both racks hung on any one carrier arm of the plating machine must receive the same plating cycle, of course. Should the racking operator program different cycles within a given pair, an automatic protective system will stop the plating machine and light an indicator lamp on the control panel to identify the error.

Desired cycles are specified by the racking operator. After he loads parts on a rack supported by the monorail conveyor, he flips out one of three hinge-type flags on the conveyor hook to indicate the desired plating cycle for that rack of parts. As the monorail indexes the rack to the plating machine, a bank of three limit switches is used to sense which flag is out. The bank of limit switches is placed so that it senses the flag setting for a given rack at the time when the carrier arm that will carry it is in a certain position on the plating machine.

1. Shuttle at plating machine	—deposits two racks of unplated parts —picks up two racks of plated parts
2. Shuttle moves to first position at pipestand	—deposits one rack of plated parts
3. Shuttle moves to monorail	—picks up one rack of unplated parts —deposits one rack of plated parts
4. Shuttle moves to second position at pipestand	—deposits one rack of unplated parts —picks up one rack of plated parts
5. Plating machine carriers advance one station; Monorail hooks advance one station.	
6. Shuttle moves to monorail	—picks up one rack of unplated parts —deposits one rack of plated parts
7. Shuttle moves to first position at pipestand	—picks up one rack of unplated parts
8. Shuttle moves to plating machine	—deposits two racks of unplated parts —picks up two racks of plated parts
9. Monorail hooks advance one station	
Cycle repeats	

2

Sequential plan views illustrate actions to transfer racks between monorail and plating machine. The transfer shuttle moves back and forth at right angles to the length of the plating machine, picking up and depositing racks by use of an overhead elevator action. It rearranges racks from the single file of the monorail to the plating machine's double file by resting one rack on a pipestand while it returns to the monorail for a second rack. It then transfers both racks to a carrier on the plating machine in one motion. The sequence returning racks to the monorail is similar.

A signal from the flag sensing switches operates an actuator at the bypass control positioner station on the plating machine. The positioner moves a rod on the plating machine carrier to one of three positions, each representing one of the three plating cycles available. As the carrier is indexed around the plating machine, a flanged member positioned by the control rod keeps the carrier from being lowered into those baths which are not part of the selected cycle.

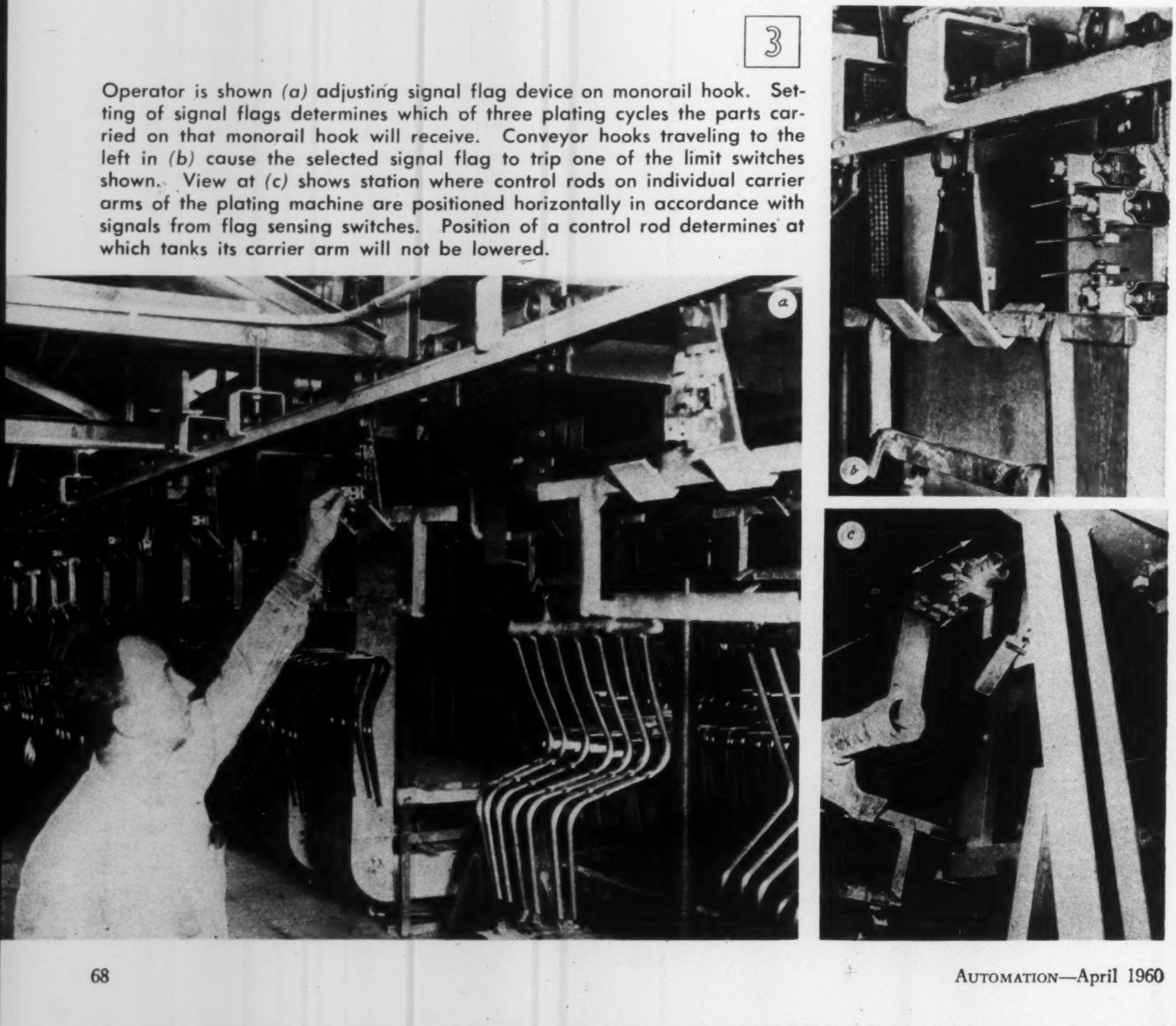
Racks of parts undergoing any of the three cycles are passed through several operations common to all cycles. These operations include cleaning, rinsing, and nickel plating stations. Parts to be brass plated go through brass plating stations in addition to the general stations, but they bypass chrome and bronze plating stations. Similarly, parts to be bronze plated bypass brass and chrome plating stations, while chrome plated parts bypass brass and bronze stations.

This type of bypass action is possible because of the design of the plating machine used. Basically, this plating machine is an indexing conveyor device that moves carrier arms from station to station and can lower and raise the carrier arms at each station. Each carrier arm is moved horizontally by its own pair of vertical tracks which are mounted on two chains that carry them around the plating machine.

Vertical movements of the carrier arms on their tracks are accomplished by an elevator bar running the length of the machine. When the elevator bar is raised, it lifts all the carrier arms that are in the lowered position. When the elevator bar is lowered, it lowers all the carrier arms which are not supported by some auxiliary means. The flanged member on the bypass device provides a means to keep racks from being lowered at certain stations.

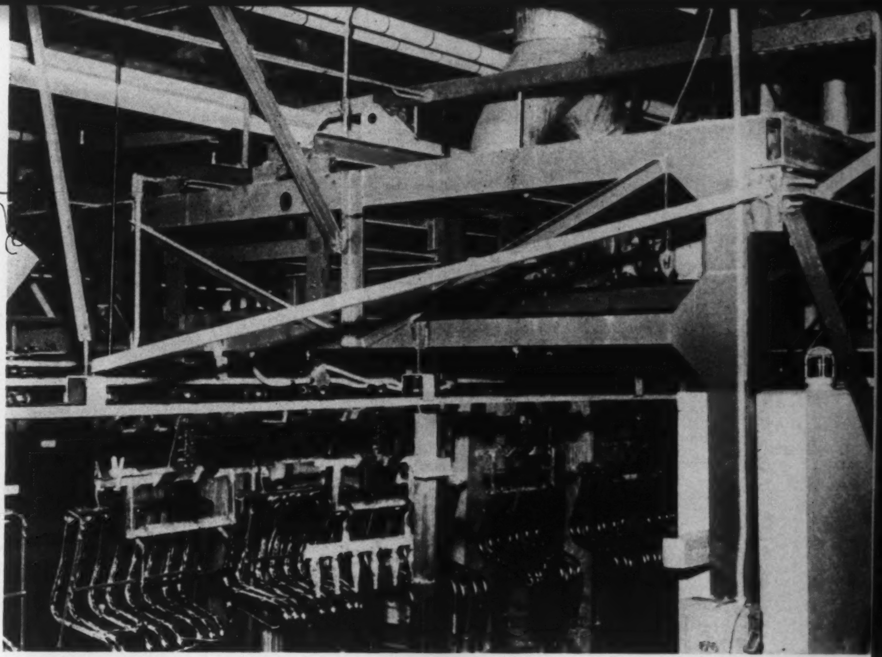
▶ Operating Points

This plating plant works an eight-hour day, five days per week, reserving Saturdays for maintenance. Timing normally used provides for immersion time at each station of 20 seconds and for transfer time of 30 seconds. Every hour 144 racks of plated parts can be removed from the machine since each carrier arm carriers two racks. The transfer time includes 20 seconds for horizontal travel, 5 seconds for low-



3

Operator is shown *(a)* adjusting signal flag device on monorail hook. Setting of signal flags determines which of three plating cycles the parts carried on that monorail hook will receive. Conveyor hooks traveling to the left in *(b)* cause the selected signal flag to trip one of the limit switches shown. View at *(c)* shows station where control rods on individual carrier arms of the plating machine are positioned horizontally in accordance with signals from flag sensing switches. Position of a control rod determines at which tanks its carrier arm will not be lowered.



4

View of transfer area shows supporting bridge for transfer shuttle. Bridge spans over both runs of the monorail conveyor in foreground and extends to plating machine out of sight at left and in background.

ering, and 5 seconds for lifting. The time cycles can also be varied to suit other requirements.

Use of this plating system meets requirements for various plating cycles simultaneously without loss of time for changeovers, and it applies a uniform coating of nickel of desired thickness. While meeting these requirements, the system has yielded these benefits: 1. Two employees are required on this operation compared to the six employees required by the previous method. 2. Uniformly high rate of production is maintained. 3. Uniform quality is maintained. 4. Rejects have been reduced 90 per cent. 5. Some savings in electricity and water have been realized.

Dimensions of carrier arms and tanks are such that racks with 8-inch hooks can be used. Parts to be plated may measure up to 40 inches on the dimension hung vertically, up to 18 inches in width across the direction of travel, and up to 28 inches along the direction of travel. The racks are custom designed for the parts handled and are Plastisol-coated. To eliminate drag-over from one tank to the next, the racks are designed to drain clean as fast as possible. When required for good drainage, extra holes are punched in the frames.

Thermostats provide automatic temperature control for all heated tanks. Steam is passed through coils for heating, and water is passed through the same coils for cooling. A centrifugal blower provides downdraft through flue openings and carries fumes along through duct work leading to a plenum chamber where centrifugal fans exhaust the fumes.

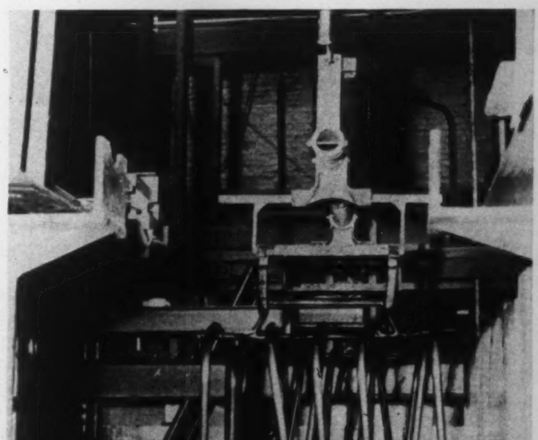
Besides the check on plating cycle selection, automatic interlocks check system operations to ensure that:

1. Each hook on the monorail is clear when it is to receive a rack of plated parts from the plating machine.

2. The monorail is accurately indexed to co-ordinate with plating actions.

3. No untreated parts are carried past the plating machine loading station.

4. Each carrier arm is accurately indexed with



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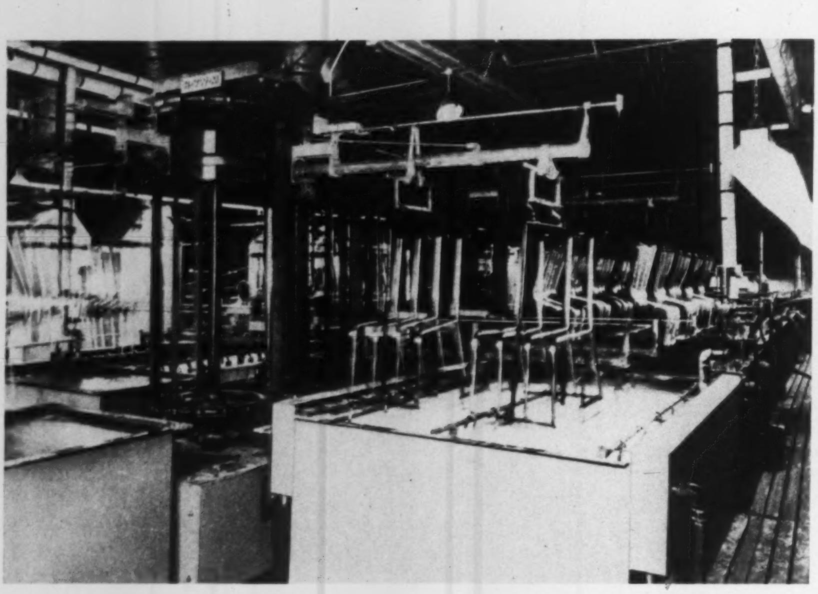
Photograph taken under shuttle bridge shows two racks of unplated parts which have just been loaded on the carrier arm that will carry them to the right and around the plating machine. In upper foreground at each side are the pipestand supports for racks of unplated parts.



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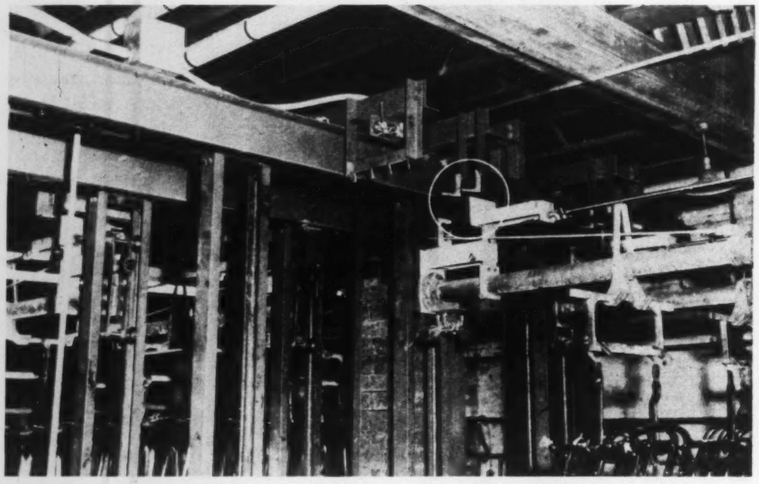
Over-all view from one end of plating machine shows chain and track arrangement which indexes carrier arms around the machine. Flanged member, at left end of control rod on top of carrier in center, can engage auxiliary bypass rails to hold carrier up while plating machine elevator bar is lowering other racks.



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Circle points out entry end of bypass rails which keep carriers calling for either of two plating cycles from being lowered at stations of the third cycle. Carrier shown in raised position has just passed from left to right through limit switch device at upper center. This device checks to ensure that the flanged member is not positioned horizontally on the carrier in such a manner that it would strike the ends of the auxiliary bypass rails.

respect to treatment tanks.

5. The bypass device on each carrier arm is properly positioned to engage a bypass track.

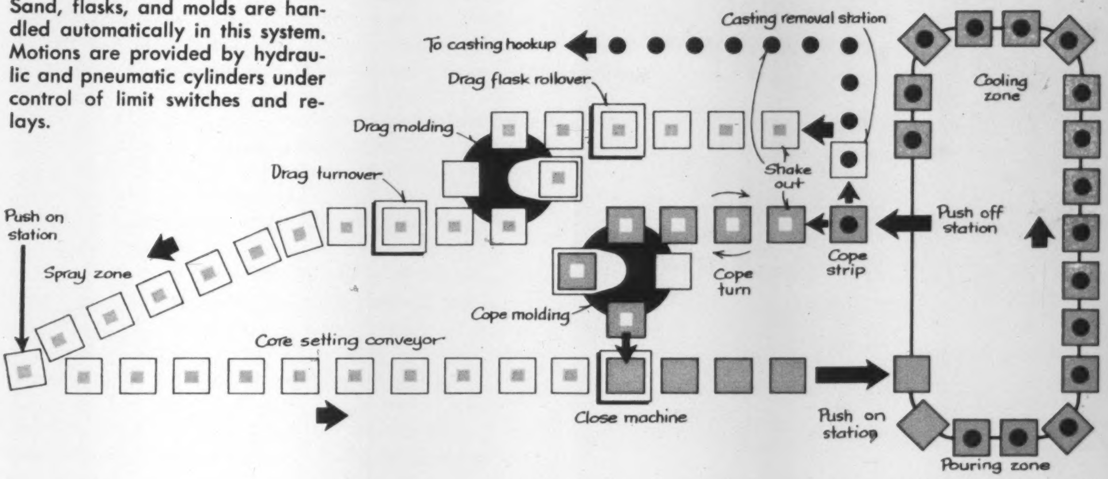
All of these conditions must be met. Otherwise, the control system stops the plating machine, and an indicator lamp on the control panel lights to pinpoint the trouble.

The accompanying illustrations show many of the features of this system.

8

Additional photograph taken under shuttle bridge shows two racks of plated parts that have been unloaded from the carrier arm of the plating machine. The carrier arm was indexed from left to right in the background. At the time the photograph was taken, the shuttle is about to lower the rack of parts at right onto the pipestand supports barely visible at top. The shuttle will then advance toward left foreground and deposit the left rack of parts on the monorail.

Fig. 1—Flow diagram depicts automated line that produces molds for engine block castings. Sand, flasks, and molds are handled automatically in this system. Motions are provided by hydraulic and pneumatic cylinders under control of limit switches and relays.


Casting removal station
To casting hookup
Drag flask rollover
Drag molding
Drag turnover
Push on station
Spray zone
Cooling zone
Shake out
Push off station
Cope strip
Cope turn
Cope molding
Core setting conveyor
Close machine
Push on station
Pouring zone

MEMO ON MAINTENANCE

BASED ON CASTING LINE EXPERIENCE

Improvements that eliminate or speed maintenance have raised average production rate of automated mold line above former short-time peak rates. Engineering for improved maintenance in this foundry includes modification of existing equipment components, design of new components, and development of new processing methods.

By **NORRIS LUTHER**, Assistant Plant Engineer, Pontiac Foundry Div., Pontiac Motor Div., General Motors Corp., Pontiac, Mich.

A PROGRAM of engineering for preventive maintenance is paying handsome production and quality dividends on the automated engine block line at the Pontiac Foundry in Pontiac, Mich.* Along this line, *Fig.* 1, a complete molding cycle is performed from the entry of sand into the molding machines to the entrance of the closed mold into the pouring and cooling zone. After castings cool, the line completes the cycle by stripping the cope from the drag, shaking out the sand and engine block casting, and returning empty flasks to the molding machines.

Initially, production on the line was hampered by many problems and reached production peaks of only 125 blocks per hour. The line now has an average hourly production rate higher than the former peaks, and now reaches peaks as high as 210 to 220 blocks per hour. Scrap due to mechanical failure on the line has been reduced to two-tenths of one per cent.

These operating improvements are based on a preventive maintenance program under the supervision of the foundry's plant engineering department. Engineering for preventive maintenance on this line involves three basic approaches: 1. Modification of existing components. 2. Design of new components. 3. Development of new methods which will eliminate trouble spots or simplify operations. The program affects all parts of the line, including mold making, shakeout, closing machine, flask handling, sand dis-

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*See "Automatic Mold Production," AUTOMATION, Vol. 5, No. 8, August 1958, pp. 38-41.

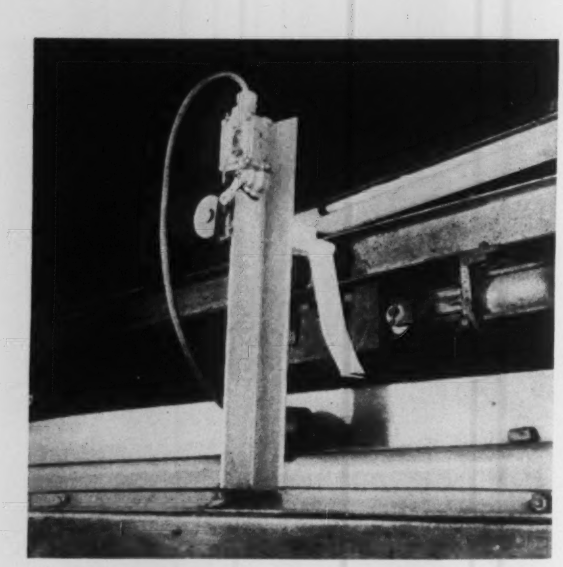


Fig. 2—One of the general changes made was to move limit switches out of direct contact with flasks. Free-swinging paddle turns cam when contacted by flask. Cam provides limited actuation of switch. Switch is also removed from area where it frequently received destructive impacts.

tribution, sand collection and treatment, power sources, and electrical controls.

▶ Electrical Controls

On the engine block line a fully loaded flask, weighing as much as 1500 pounds, must be moved in a short cycle time between workstations. Pneumatic and hydraulic cylinders transmit the power for these movements. As in any modern foundry, the electrical controls governing the actions are a major problem. These controls are constantly exposed to an atmosphere containing many sand particles.

Pressurized Enclosures: Sand was filtering into control and junction boxes and fouling contacts. A fouled contact could cause a missed cycle and possibly a jam-up of flasks at the next station. To keep sand out, small compressed air lines were run into control and junction boxes. Pressure inside the boxes is kept 2 to 4 psi higher than atmospheric pressure, creating an "air shield" around contacts.

Pressurizing the control boxes, however, did not solve the entire problem. Contact contamination could still be caused by foundry conditions whose effect was not eliminated by the air system. The control circuits are operated at 110 volts, desirable for safety reasons, but below the critical sparking voltage for even relatively small contamination build-ups. A slight amount of contamination and the contacts would occasionally fail to conduct current. Such an occurrence meant shutting down the operation to locate the contact and clean it. The job of cleaning contacts became a daily and time-consuming task. This problem was attacked further by installing voltage peaking equipment.

Voltage Peaking: Allen Bradley Co. engineers developed a static "peaker" which meets this problem. It superimposes a substantial voltage pulse on the control circuit at the peaks of each cycle (120 times per second). These pulses search out any supposedly closed contacts that might be separated slightly due to contamination. The pulses produce an arc and start conduction which is then maintained by 110 volts. The pulses are of such small energy content that they offer no increase in danger to personnel above the shock to be experienced from an "unpeaked" 110 volt circuit.

Longer Switch Life: A problem involving both electrical control and materials handling was the destruction of limit switches. As originally installed, limit switches were right on the line of movement. As flasks moved through molding and shakeout areas, they would frequently bang into the switches and break them off. To avoid breakage, limit switches were in most instances moved off the direct line of movement. They were rigged to free-swinging paddle actuators on the line, *Fig.* 2. These actuators, touched by the flasks, nudge an overriding cam which actuates the limit switch. A critical point in limit switch service life is bushing wear. Plant engineers are now recommending that all limit switches be equipped with steel bushings and chrome plated shafts.

Control Separation: The automated engine block line is controlled by about 120 limit switches or safety interlocks. These switches were wired from a single control box. That caused some difficulty in

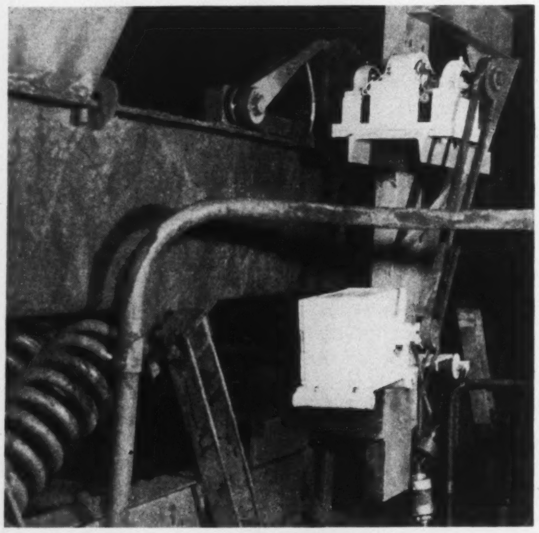


Fig. 3—Special switch arrangement was developed to monitor operation of oscillating conveyor. Proper oscillation of conveyor trough drives a ratchet wheel at a given average angular velocity. A standard zero switch driven by the ratchet wheel detects drop below preset speed.

getting at shorted lines and in identifying which segment of the line was causing trouble. As a result, a plan was developed to install separate junction and control boxes for the shakeout area. Some departmentalization of electrical control functions is expected to result in a smoother-functioning system.

Sand Handling

Improvements have also been necessary in the handling system which brings sand to the molding stations and returns it to the mixing and storage units.

Screen Eliminated: Sand is returned from the shakeout stations via a basement level vibrating shaker. Sand is passed from this shaker to a hex screen which rotates slowly, separating sand from scrap iron. In the section of the shaker immediately before the hex screen, a double level vibrating screen was installed. The top level had holes punched in it, allowing sand to fall freely to the lower level and retaining scrap subsequently discharged to a refuse area. It was found, however, that scrap was jamming the holes, causing sand to gather around the projections on the lower level. Feed to the hex screen was often incomplete, and occasionally the shaker would stop altogether because of clogging. It was found that this elaborate double screen was unnecessary. Sand and scrap could be passed directly into the hex screen and obtain successful separation.

Drive Monitored: The drive which gives the shaker its motion also created a problem. The motor drive functions at approximately 1800 rpm, imposing a thrust on a rubber bushing, which gives the shaker its vibratory motion. Electrical controls for this operation are attached directly to the motor drive. Plant engineers found that, although the motor drive maintained its 1800 rpm, the rubber bushing sometimes did not impose a corresponding thrust against the shaker. Thus, the shaker could come to an almost complete halt, while the drive was still operating at full speed. Sand would pile up on the conveyor, occasionally to such depth that the whole system had to be shut down while maintenance men shoveled sand from the clogged conveyor.

After checking a number of sources and finding none which could offer a way of monitoring this condition, Pontiac devised what it calls a "zero ratchet switch." This device consists of a ratchet wheel actuated by the movement of the shaker itself, *Fig.* 3. The ratchet wheel, in turn, drives a zero switch. The zero switch is pre-set to operate at a certain average rpm of the ratchet wheel. If the ratchet does not operate the switch at the prescribed rpm level, the whole sand system is immediately shut off by the zero switch. This gives an immediate positive check against sand accumulation because of conveyor drive failure.

Cutter Bars: As sand moves into the hoppers and to the mixers before molding, it passes among cutter bars which break up lumps of sand and prevent any large foreign particles from passing through. These cutter bars are approximately 1/4 inch thick and spaced about 1 inch apart. Originally these bars were mounted in a straight line and vibrated in a horizontal plane. Slightly moist sand could easily clog up the openings between the bars. By lowering every other cutter bar at a slight angle, *Fig.* 4, the clogging problem was solved.

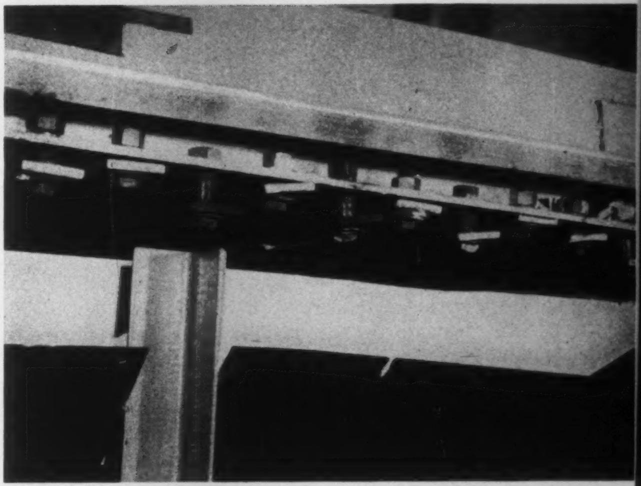


Fig. 4—Horizontally oscillating cutter bars break up lumps in descending sand stream. To avoid clogging, opposite ends of adjacent bars are mounted lower than the single plane in which all bar ends were originally mounted.

Hopper Material: Some adjustments have also been made in the sand hoppers over the cope and drag molding machines. Hoppers were originally constructed of mild steel, and were subjected to corrosive attack by the sand. Resultant pitting allowed accumulations of sand to build up on side walls, causing uneven filling of flasks. Hoppers have now been converted to stainless steel construction. Square corners have also been rounded off, and leaves added to the sides of the hoppers to prevent sand accumulation.

Flask Handling

To eliminate downtime, a number of changes have been made in the flask handling system. Flasks are moved to and from workstations by cylinders, in most cases powered by plant air at 90 to 95 psi. Air cylinders, however, have been replaced by hydraulic cylinders at four key points in the system.

Hydraulic Actuators: As the poured mold leaves the cooling conveyor, it moves into the stripper, where the cope is separated from the drag. An air cylinder had been used at this point to push the flask into the machine. It was found, however, that frequently hot metal would spill over the edge of the flask, causing the flask to hook or even fuse temporarily to the actuating arm. Air pressure would build up, and then abruptly push the mold into the station with terrific force. As a result, the flask often overrode the stop, shearing limit switches, etc. To avoid the uncontrolled advance, a hydraulic cylinder was installed. This cylinder operates at 300 to 400 psi.

Other hydraulic cylinders are also used in the stripper-shakeout area. A hydraulic cylinder moves the cope into the idle station immediately preceding the cope turn-around. A cope which shoots through the idle station too fast can block the swinging action of the turn-around, damaging flasks and shearing turning pins. Another hydraulic cylinder is now being used at the point where the completed mold is put on the conveyor before pouring. Hydraulic power is used here so that core assembly tolerances will be held constant.

Cylinder Connections: The actuating cylinders posed another problem. Some of the cylinders used have strokes of 5 feet. In the extended position this could cause the cylinder to depress and catch on a projection of the flask. This not only caused jam-ups on the line, but misalignment of cylinder arms. A system of steel trolleys was devised, *Fig.* 5, which ride as a carriage to support the cylinder arm as it pushes a flask to the next station. This simple device has now been installed on all cylinder arms in the system.

A considerable amount of pipe breakage was also being experienced on the air and hydraulic cylinder feed lines. As the cylinder moves forward and back, it sets up a natural vibration. This vibration has its greatest effect at the point where feed lines enter the cylinder. At this point the thin piping tends to support the whole cylinder. The last six inches of the feed pipes have been replaced with Neoprene hoses. The hoses are flexible and have substantially cut down on broken cylinder lines.

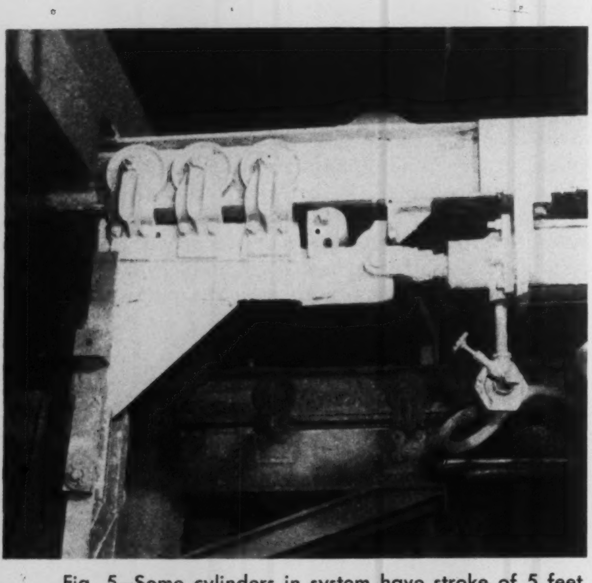


Fig. 5—Some cylinders in system have stroke of 5 feet. To support the free ends of the piston rods on long-stroke cylinders, trolley carriages were provided.

Process Modifications

One of the biggest continuing maintenance problems on the whole line was in the skin drying oven, where drag molds were baked free of moisture prior to closing with the cope. Bearings, sprockets, and chains in this section were operating under constant temperatures of 250 to 300 F, with attendant problems in wear and erosion. When trouble occurred there, maintenance people had to wait until the oven cooled down, requiring lengthy shutdowns of the whole production line. This oven has been eliminated from the line through the use of an automatic sprayer, *Fig.* 6, which applies to each drag mold a carbon drying agent in a hydrocarbon carrier. No heat is required to achieve the dryness necessary to make a perfect casting.

Another change was developed in conjunction with Osborn Mfg. Co. who designed, built, and installed the line in 1954. The change resulted in a simplified machine operation which contributes substantially to reduced maintenance. In the original line, cope molds emerged from the cope molding machine, moved to an idle station, to a rock-up inspection station, to an idle station, and then in a raised position into the close machine. The drag

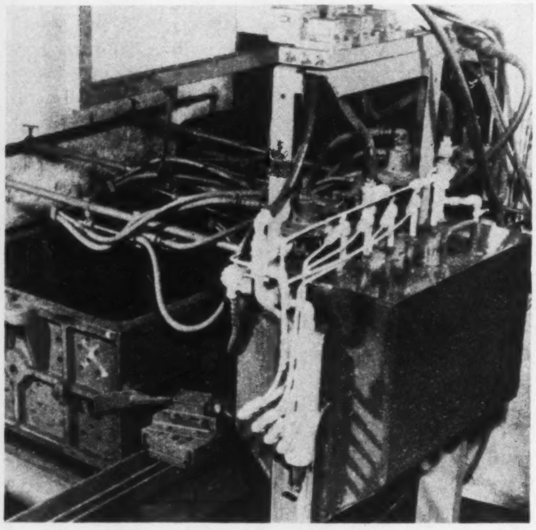


Fig. 6—Change in method of processing substituted this spray system for an oven formerly used to eliminate moisture in drag molds. Conveyor parts operating continuously in oven were cause of considerable downtime. New system drys molds by spraying them with carbon drying agent.

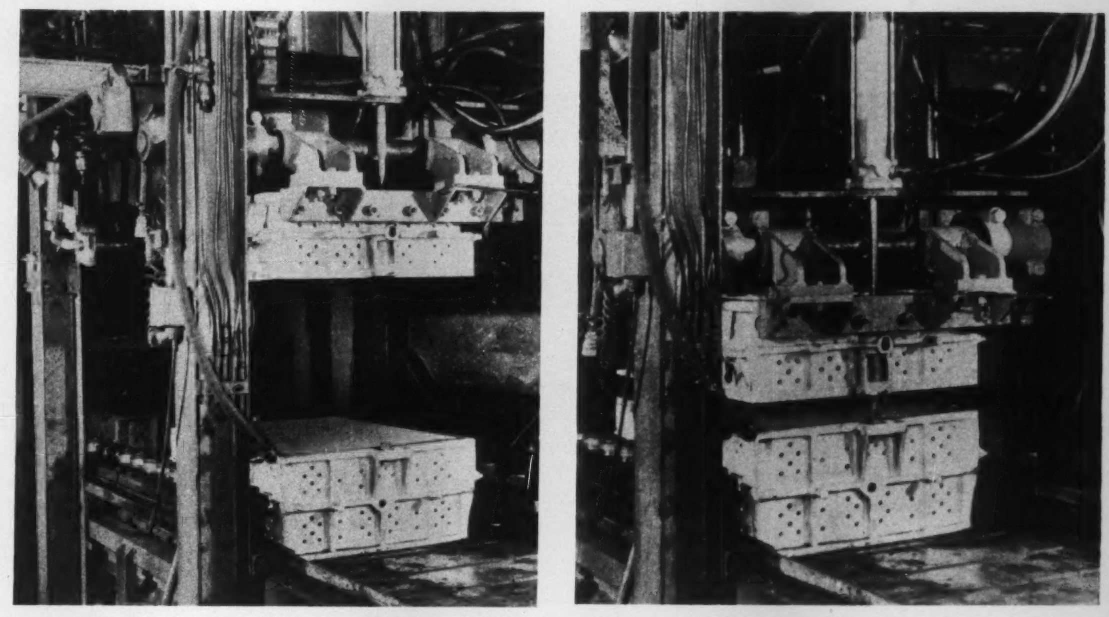


Fig. 7—Improved machine to close cope on drag mold receives cope at elevated level, lowers it on drag received at lower level, and ejects closed mold at same lower level. Closing is thus completed in one smooth motion which causes the least disturbance of cores in the mold.

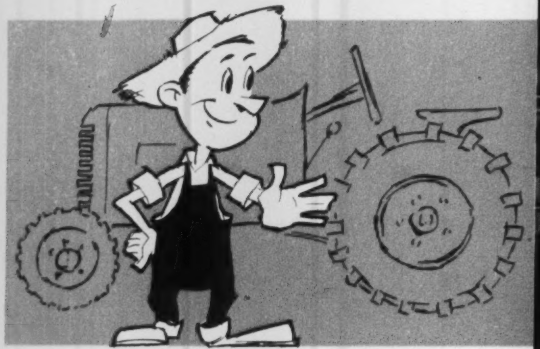
moved up to the cope, and the completed assembly came down to the original drag conveyor level for movement to the pouring zone.

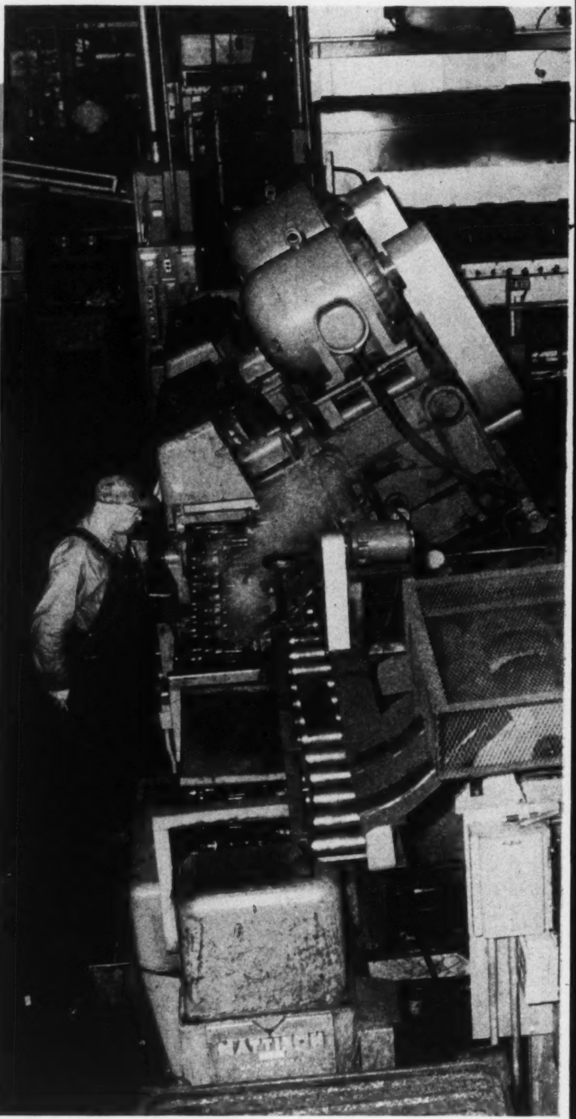
Two factors made a change desirable in the closing area. For one thing, because of the smooth functioning of the line and its excellent program of preventive maintenance, rock-up inspection of the cope was deemed unnecessary. Secondly, any unnecessary vibration of the cores after they have been set may throw the completed engine block out of tolerance. The earlier close machine was improved. Now the cope moves from the molding machine directly into the close machine, with the cope in an elevated position. When the drag has moved into position, the cope is lowered on top of the drag and closing is completed in one motion, *Fig.* 7. In this way, joining of cope and drag is accomplished with a downward push, always more easily controlled. The new design involves less jarring than an upward thrust and then a downward movement.

By improving preventive maintenance, Pontiac is establishing a smooth functioning production installation. It requires dependable operation of pneumatically and hydraulically powered heavy duty machines and materials handling equipment, controlled by delicate, sensitive switches and interlocks, in an atmosphere where sand and moisture are a constant threat.

can we help?

It has been pointedly mentioned at various times that in engineering automated systems new as well as old techniques and devices may prove extremely useful. Practical results require the investigation of all available equipment that can contribute to the effective development of suitable automatic lines. Information on such equipment is presented in various departments of the magazine each month as useful data become available. To aid in obtaining detailed data for further evaluation a post card is included on page 19. Take advantage of this service. The Editors will be glad to help in this or any other way.





PRODUCTION OF THROWAWAY PLOWSHARES APPLIES CONTINUOUS EDGE GRINDING

By ARTHUR MATTISON
Chief Engineer
Mattison Machine Works
Rockford, Ill.

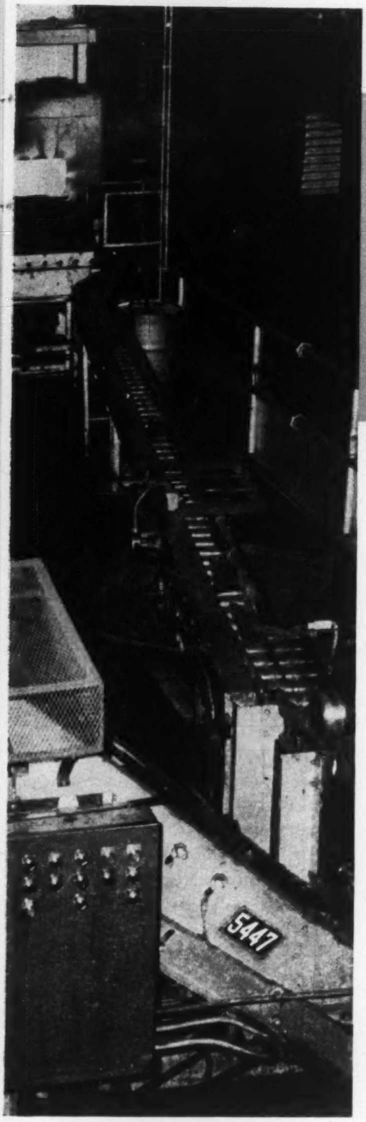
FARMERS TOO are interested in more economical production operations. Their desire to reduce plowing costs has led to interest in reduced plowshare costs and increased tractor horsepower to allow plowing at higher ground speeds. For example, it is now possible to plow at ground speeds up to six miles per hour.

In the days of low-speed plowing, plowshares consisted of a complex welded and highly polished assembly. After use, these plowshares required resharpening by a skilled metalsmith. Stocking of standby shares and paying the metalsmith represented important costs to farmers.

In view of these plowshare costs and the increased plowing speeds, the old-fashioned plow bottom was redesigned. Slicing soil for making proper seedbeds is not as simple as it might seem. In fact, plow bottoms are just as scientifically designed as many industrial cutting tools. This type of "cutter" must penetrate the soil quickly, hold depth without chattering at top plowing speeds, fracture the furrow slice thoroughly and uniformly, and turn it without pitching. It must have good scouring and trash-covering characteristics. It must also be able to perform efficiently in sod or heavy clay at low speeds.

These qualities are the result of good plow geometry—a correctly graduated curve with progressive twist across the share and upper moldboard so the furrow slice is gently, but firmly controlled at every point. An incorrect form with low-pressure spots prevents efficient scouring. High-pressure areas cause uneven and costly moldboard wear.

The result of plowshare redesign with these cost and performance considerations in mind is a high-



Interest in economical operation "down on the farm" led to product redesign and automatic operations in a plant producing plowshares. The new plowshares are designed to be thrown away after use rather than resharpened. They must be made in large quantities for sale at economical prices.

Fig. 1—Partial view of automated plowshare line that includes operations of cutting off, forging, blanking, piercing, heating, quenching, drawing, roll-forming, surface grinding, shot-peening, painting, and packaging. Two inspectors service the entire line, which produces plowshares at the rate of 720 pieces per hour. Shares come from the heat-treating operations, at right background, to a roll-forming operation at right foreground. They then pass through an automatic edge grinder that incorporates the inclined heads at left center.

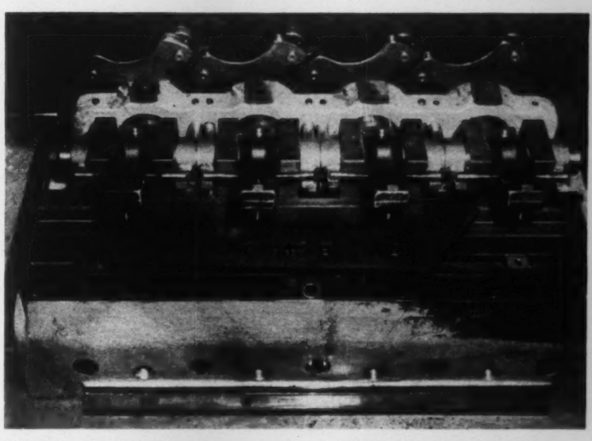


Fig. 2—Plowshares are moved past the grinding heads on pallets that slide on ways. A chain advances the pallets and returns them under the machine after unloading. The plowshare is fed from a magazine and located by pins registering with the bolt holes in the share. The clamps are automatically brought down on the piece by cam action.

speed, light-draft bottom. A plowshare made by John Deere Plow Works of Deere & Co. at Moline, Ill., for the new design offers convenience similar to a razor blade in replacement and throwaway economy. Now, when a share gets dull, the farmer simply removes three or four bolts and replaces it. This keeps his capital investment more productive, and the cost of replacement, all things considered, is much lower than the cost of replacing and reconditioning an old-fashioned share.

▶ Need To Automate

As the idea of throwaway shares gained acceptance, John Deere production men realized that output would have to be doubled over a period of four years to take care of the growing replacement market. It was decided to use automated machinery, *Fig.* 1, to produce the plowshares.

These plowshares are not flat, rough stampings, but are precision cutting tools, geometrically and metallurgically well-formed. They require several well-controlled operations for their production. Operations include cutoff, forging, blanking, piercing, heat-treating, quenching, drawing, roll-forming, surface grinding, shot peening, painting, and packaging. Sixteen different types of plowshares, from 14 to 22 inches in size, are produced in one automated line at the rate of 720 pieces per hour. Two inspectors service the entire automated line from forging to packaging.

The unique grinder designed by Mattison Machine Works machines the long edge of the plowshare which is to fit against the moldboard. The grinder finishes that edge in a single straight pass and holds parallelism with the first and last mounting holes within plus or minus 0.005 inch.

Performing the Work

The grinder is a two-wheel machine with each wheel spindle supported by a parallel rocker-arm suspension rather than by a slide on a way. Each wheel is individually driven by a 75-hp motor. The 75-hp motor is mounted directly on top of the grinding head and transmits power to the spindle through a timing belt drive. The movable portion of the head bears against a hardened end plate on the feed screw and is held against it by a heavy spring force. The spring is so stiff that it never moves under normal grinding conditions.

Each workpiece is moved in turn past the roughing wheel and then the finishing wheel. The roughing wheel is a 36 grit segmented wheel that cleans itself automatically. In operation, the rougher is adjusted to a point at which it is pulling 100 per cent of rated horsepower at peak load. Stock removal averages 0.150 to 0.190 inch. Wheel life is about 12,000 pieces, roughly two times the daily production of the machine.

From the roughing station, the plowshare is carried under a 60 grit finishing wheel. This wheel removes about 0.015 inch of stock. If the wheel tends to load up, the operator can actuate the wheel dresser simply by pushing a button on the control panel.

Workpiece Handling

Plowshares are brought to the grinding machine from the roll-forming operation where they are given the twist which blends with the curvature of the moldboard and shin. A roller conveyor feeds them into a magazine, one on top of another. An air operated shuttle feeds shares one at a time from the bottom of the magazine to pallets on an over-and-under conveying arrangement.

The first three pieces in the magazine must be handloaded to start an orderly stack. An overload switch operates whenever the stack is reduced to three pieces or less, preventing any more from being ejected from the magazine until the stack builds up. A stream of grinding compound is directed into the magazine to lubricate the plowshares and make them easier to load.

Parts ejected from the magazine drop onto a stationary bar. As a pallet, *Fig.* 2, advances, a driver pin on the pallet pushes the plowshare off the bar. As the share drops on the pallet, it is guided into position by two adjustable pins which locate the part from its first and last bolt holes. Before clamping takes place, a spring-loaded roller on the conveyor urges the shares against the pins in the same direction as the grinding forces will. This prevents possible shifting of the piecepart during grinding.

Four cam-actuated clamps hold the plowshare firmly on each pallet for grinding. Clamping pressure is preset by the use of setscrews at the ends of the clamp arms. The pallet is advanced by an endless chain drive along the machine ways. Neoprene seals between pallets keep grit and chips away from the precision ways and roller chain. As a further precaution, filtered coolant is pumped under pressure into the cavities of the pallets. The coolant, gushing out through openings between the pallets and the conveyor, prevents entry of grit.

After the pallet passes both grinding heads, the clamps are opened by cam action, and an idler wheel mounted along the conveying track lifts the plowshare off the pilot pins. The share reaches the unload station in a canted position between the pallet and stripper wheel. There an electromagnetic unloader, *Fig.* 3, picks the plowshare off the pallet and drops it on a gravity roller conveyor for movement to the next operation.

The unloader has an electromagnet mounted on a pair of swinging arms. The magnet is selectively

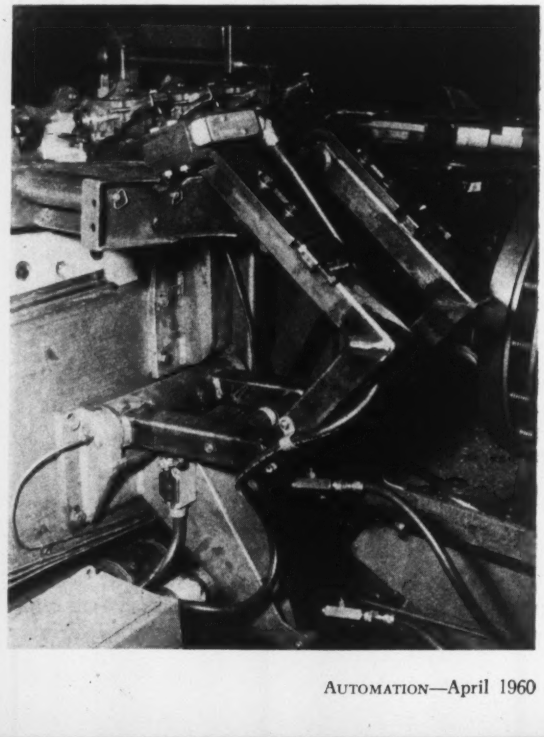


Fig. 3—Photograph taken during construction indicates method of unloading plowshares from pallets. The pair of pivoted arms carries an electromagnet. The air cylinder swings the magnet over to the pallet and returns it to the position shown over the outgoing roller conveyor. Limit switch actuated by arm de-energizes magnet to drop share on conveyor.

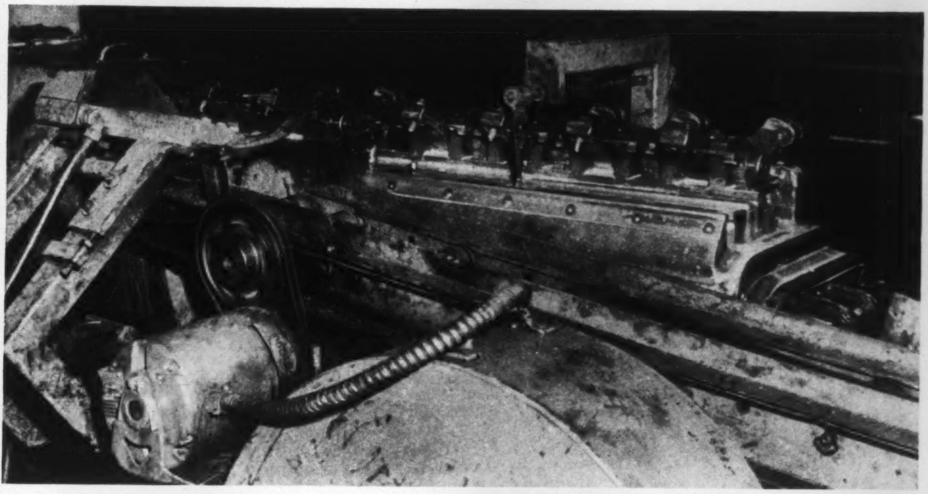


Fig. 4—Feeler over pallet at center checks to be sure plowshare has been unloaded. The empty pallet then is moved back through the bottom of the machine to the loading area.

energized from 24-volt dc supply (dry rectifier) in the control panel. The arms are swung from one position to another by a pneumatic cylinder. Flow controls are used to adjust cylinder action speed in both directions. The arms stop in the retracted position when they actuate a limit switch that de-energizes the magnet.

Unloaded pallets, *Fig.* 4, ride around the end sprocket and are carried back under the machine to the loading position. Twenty-two pallets are used in the machine. Since the pallets expose their way surfaces in riding over the sprockets, carefully directed jets of coolant flush them thoroughly before they contact the table ways.

An endless heavy-duty roller chain drives the pallets. It is driven through a slip coupling by a variable speed electric drive. The speed control permits the machine to be synchronized to the overall line speed. The clutch is adjusted to handle a normal grinding load without slipping. An electric brake is included on the drive unit to provide precise inching.

▶ Control Provisions

An automatic size control on each grinding head continuously measures the ground workpiece and actuates the spindle infeed when parts approach their upper size limit. With the machine controls set for *Automatic*, the grinding wheel heights are automatically maintained within a range of approximately 0.006 inch.

Air gage probes manufactured by Sheffield Corp. are located close to the trailing edges of the grinding wheels. The probes are connected to remote indicator and switch units. When wheel wear allows the height of the ground surface to reach a control point (the zero point on the dial indicator) a switch is closed. Closing of the switch actuates a solenoid valve which jogs the grinding head feed cylinder by one increment. This feeds the wheel inward 0.002 inch. Succeeding plowshares read under zero until additional wheel wear requires a new adjustment. For setting up, manual feed is provided by a hand crank. Pushbuttons also permit manual operation of the jog feed.

Besides the low-limit control already described for the feed magazine, there is also a high-limit control. A limit switch is arranged to sense when another share is fed on top of a stack of 15 shares. The sixteenth share causes the switch to reverse the roller conveyor feeding the magazine. Succeeding shares are dumped into an overflow hopper. When ejections from the magazine bring the total in the magazine to less than 15, the high-limit switch reverses the magazine feed conveyor and normal operation is restored.

Safety switches control possible malfunctions in pallet loading. If the unloader fails to remove a share from a pallet, if a share is not properly fed from the magazine, if a share isn't located properly, or if the holddown clamps fail to open, limit switches detect the problem and shut off the machine. Since the loading magazine controls prevent piling up, the controls provided make it virtually impossible for the loading operation to malfunction in a way that can damage the machine or grinding wheels.

MANUFACTURING AUTOMATION

Fourth Conference on Manufacturing Automation, at Purdue University, Lafayette, Ind., April 11-13, will be co-sponsored by Purdue University, AUTOMATION magazine, and the Manufacturing Engineering Council. Conference has been arranged for top management and manufacturing engineers who plan, design, and install automated systems for industry. See page 143 for more information.

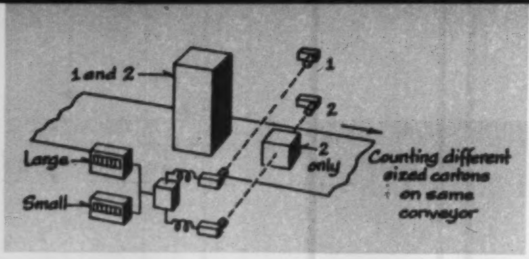
APPLYING

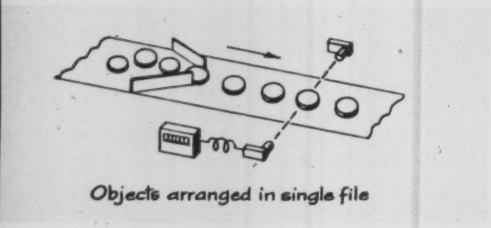
Counting is basic to many control problems. With the development of various types of counters that utilize electronic techniques, industry has been provided with inexpensive and flexible tools with which to obtain efficient control of processes in a variety of applications.

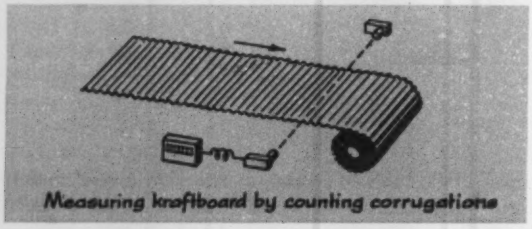
By **R. W. RUSSELL**, Special Factory Representative
Electronic Controls Div., Veeder-Root Inc.

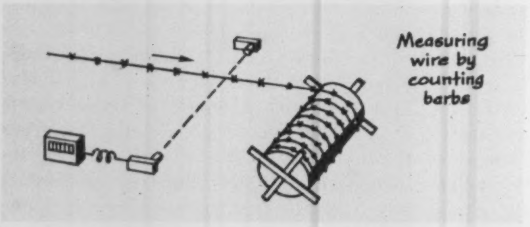
INDUSTRIAL counters have been termed the "poor man's automation" because at relatively low cost, in comparison to elaborate control systems, they can bring a degree of automatic operation to machinery and processes that formerly required detailed human supervision. Their essential function, of course, is to count and to record in unit registration desired objects or impulses. But with the development of a predetermining selection feature, it became possible to make counters perform control and actuation functions.

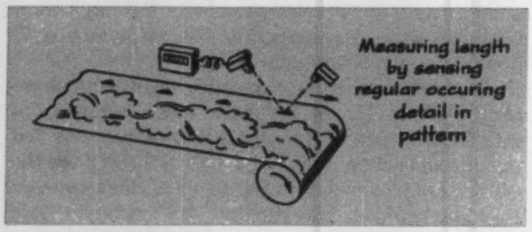
In particular, these statements apply to the electronic counter—a type in which signals representing the events being counted are directed to an electronic counting circuit that is capable of totaling and indicating the number of signals generated. The electronic counter contrasts with the electromagnetic counter—in which an electromagnetic relay responds

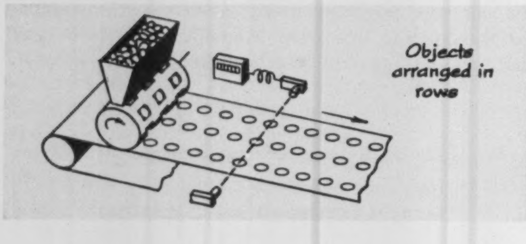

1 and 2
1
2
Large
Small
2 only
Counting different sized cartons on same conveyor

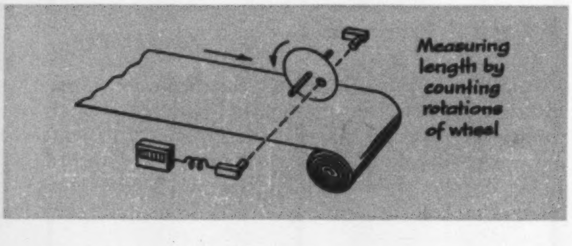

Objects arranged in single file


Measuring kraftboard by counting corrugations


Measuring wire by counting barbs


Measuring length by sensing regular occuring detail in pattern


Objects arranged in rows


Measuring length by counting rotations of wheel

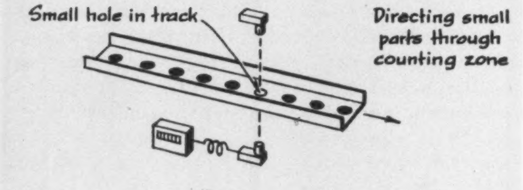

Small hole in track
Directing small parts through counting zone

Fig. 1—Examples of how counters can be applied suggest the usefulness of such devices in industry. With a predetermining type of counter, it is possible not only to count various objects and events but also to obtain an electrical signal that can be used for control purposes (stop motors, actuate gates, cause webs to be cut, close valves, etc.). Photoelectric devices are particularly suited for use as sensors with electronic counters.

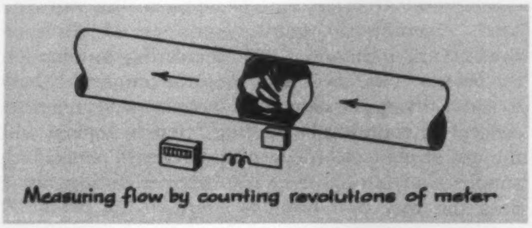
ELECTRONIC COUNTERS

to successive electrical impulses and actuates a totalizing unit—and the mechanical counter—in which mechanical linkage is used to actuate a totalizing unit. The electronic counter offers advantages which are not obtained with other types of quantitative recording devices. Its speed enables it to register 5,000 counts per second, and under certain conditions, even much higher. Because the motionless electronic circuits eliminate the problems of complicated mechanical linkages, accuracy and reliability are improved.

▶ Photoelectric Sensors

An electronic counting installation must include means of generating distinctive electrical impulses. Industrial experience points to the photoelectric cell as an ideal sensor for use with electronic counters, though obviously, any device such as a contact switch, magnetic switch, etc., capable of generating a signal can be used. With photoelectric devices, however, sensitivity is extreme, allowing the counter to work successfully with tiny objects that are too small or lightweight to actuate a contact-type switch. In other cases, the object being counted might be freshly painted, precluding the use of a contact-type switch. The photoelectric system need be subject to an interruption of its light source for as briefly as 120 microseconds in order to jog the counter. Remote operation is no problem, and the standard counter can usually be placed up to 100 feet from the counting station. Flexibility is another advantage, permitting the counters to count both fast and slow, to count irregular objects, to make linear measurement of materials, to count in units, dozens, or other batch quantities, and even to record liquid flow. In terms of service life, the electronic counter stands in a class alone, counting millions of units or operating for thousands of maintenance-free hours.

In a counting application involving a photoelectric sensor the objects to be counted must pass between a light source and a cell. As each object interrupts the light beam focused on the photoelectric cell, an electrical impulse is generated. This impulse is usually too weak for direct utilization by the counter, so it is first amplified electronically, then is "squared off" and stretched in order to intensify the contrast between "on time" and "off time" of the signal representing objects being counted. These shaped pulses are then used to actuate the counting section.



Measuring flow by counting revolutions of meter

▶ Counting Techniques

Counting small objects is one of the more basic applications for electronic counters. In packaging, for example, where tiny objects of small unit value are weighed rather than counted, it is generally necessary to toss in a few extra objects to make sure that a full measure is packaged. This unnecessary drain on profits can be eliminated by positive, accurate counting.

Objects of sufficient height (approximately ¼ inch) can easily be counted on a conveyor belt carrying the objects past a horizontal light beam. Smaller objects may have to be counted on a perforated or mesh-type belt or a transparent surface with the light source mounted beneath or above the belt and the pickup head on the opposite side. Installations should first be planned to align the objects in single file. If this is too difficult, it may be possible to count rows of known quantity. Another approach is to fill shallow depressions or containers that will hold an unvarying quantity, and count these. Only in extremely unusual circumstances will it be necessary to resort to such measures, however.

In applying counters to the measurement of length it is important to study the material to be measured to determine if there is any regularly occurring projection, perforation, pattern detail, or other reference point which may be utilized as a counting unit. For example, corrugated kraftboard is being successfully measured in linear units by means of electronic counters that register the number of corrugations passing at high speed. Barbed wire may similarly be measured by means of counting the barbs. If necessary, notches or perforations can be placed at known intervals, and these counted —but generally for uniform, unmarked materials, there are better solutions.

For example, rollers or discs of known circumference can be placed in contact with the work. A hole in such a disc, passing between the elements of the photoelectric system causes the counter to register the number of revolutions that have been made. A disc of 1-foot circumference causes the counter to register directly in linear feet.

For even greater accuracy, more holes may be placed in the disc or roller. This permits fractions of the unit measure to be recorded. The size of the wheel and its calibrations are the determining factors for the counter's accuracy.

A similar approach can be applied in measuring liquids. For instance, a rotary liquid meter in a pipe can actuate an electronic counter which registers the number of revolutions made by the meter. This yields accurate measurement even at extreme temperatures. A simpler application involves counting of dip-buckets or other batch-type conveyors. Where a screw-type conveyor (moving slurries or semiliquids) delivers reasonably uniform volume with each turn of the screw, it is a simple matter to let an electronic counter register the total number of revolutions.

Predetermining Counters

The line of electronic counters manufactured by Veeder-Root Inc. includes instruments equipped with predetermining selection knobs, by means of which any desired total within the maximum registration range of the instrument may be preset. When this selected total is reached, the counter actuates a switch which may be used to turn conveyors *Off* or *On*, to control motors or other machinery, or perform any desired function, provided it may be initiated by electrical contact.

Furthermore, the line of counters is available with any number of decades and with additional groups of presetting controls which makes possible the use of sequential predetermining functions. These features enable a relatively sophisticated control system to be formed from relatively simple components, as is illustrated by a bottling machine developed by the Lakso Co. The machine uses a specially modified four-decade predetermining counter which operates a transistorized switching circuit. The equipment is wheel-mounted so that it can be moved from one location to another on the production floor. It is positioned near a conveyor that feeds it empty bottles, and these are guided along a track under the filling head. The tablets are dumped into a stainless steel hopper at the top, and are moved by gravity to a vibratory feeder which arranges them in single-file as they move along a special brass track. This conveyor also screens out dust and chips. At the end of the track, each tablet passes through a photoelectric beam, causing the electronic counter to register one unit. The counter is preset for any desired number of tablets, and when this number is reached, an impulse is generated which operates the circuits, causing a conveyor gate to shift, directing the tablets to an unfilled bottle. The filled bottle moves on and is replaced by an empty one.

A difference in linear speed between the vibratory feeder or first belt and the track belt establishes an initial spacing between the tablets. Because of the high speed at which they travel through the machine, additional separation is needed. This is achieved by means of a sponge rubber wheel spinning at high speed just above the track. It is adjusted so as to exert light pressure on the tablet and "shoot" it past the counting station at high velocity.

For certain types of products, the vibratory feeder may be replaced with a brush which performs the same function. The track is also removable and may be replaced with a special V-groove track for gelatine capsules, coated pills, and certain other soft type units. Both tracks are adjustable to the size and configuration of the product, and any pill, tablet, or capsule can be handled, regardless of its shape. The machine is rated at 1500 counts per minute limited by the necessity for allowing the conveyor gate to shift without disrupting the accuracy of the count.

A unique design feature involves the use of an ammeter on the control panel to register the strength of the photoelectric beam. Because many types of tablets (aspirin, for example), give off a surface powder or dust, there is always the chance that dust will accumulate on the projector lens or the glass over the photoelectric cell, cutting down the intensity of the light until the counting accuracy is impaired. By periodically noting the light intensity, as expressed in amperes, the operator can tell when it is necessary to shut down the machine momentarily and wipe the surfaces of the lenses. This feature also provides an additional safeguard against failure of the light source for any reason.

Other applications for predetermining counters can be cited. For high speed machines that must be slowed down in stages at the end of each batch, the predetermining controls can be set to actuate the slow-speed switch a short time before the end of the run, or to flash a light, or ring a bell to warn the operator. Using a second predetermining control enables the equipment to be stopped at a desired count. This type of application is particularly useful in coil-winding machines and machines for winding paper, wire, thread bobbins, and plastics, including film and tapes.

The use of electronic elements in a counting system can also be beneficial to systems employing mechanical counters. By preceding the mechanical register with a decade tube or a number of decade tubes, the main counter need only be jogged every 10, 100, 1000 or more times that a unit is counted; or it may be jogged in different multiples, such as every 12 or every 144 times. This correspondingly extends the life of the mechanical counter. It also increases the total counting capacity in direct proportion to the number of decades added by the arrangement.

This article has only highlighted the many diverse areas where counters can be applied—for only the user's ingenuity limits the usefulness of electronic counters in industry. With increasing automation, the role of counters is assured since counting is basic to so many types of control actions, and since the concept of counting by "seeing" that is implied with the use of photoelectric sensing devices is particularly simple and straightforward—approximating as it does the way that humans count.

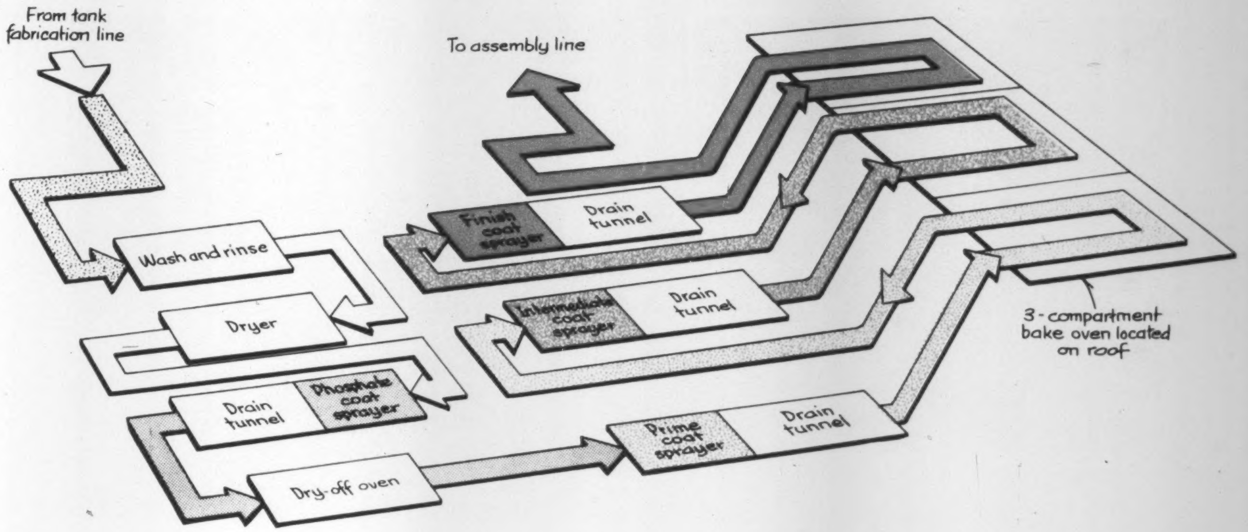

From tank fabrication line
To assembly line
Finish coat sprayer
Drain tunnel
Wash and rinse
Dryer
Intermediate coat sprayer
Drain tunnel
3-compartment bake oven located on roof
Drain tunnel
Phosphate coat sprayer
Prime coat sprayer
Drain tunnel
Dry-off oven

Fig. 1—Diagram illustrates the continuous production line for finishing distribution transformer tanks at the Athens, Ga., plant of Westinghouse Electric Corp. Line speed of the conveyor system is 5 feet per minute. Using a combination of spray and flow coating methods, the line provides consistent coatings of paint film thicknesses which vary less than 0.0003 inch from top to bottom of each steel tank.

APPLYING MULTIPLE-COAT FINISHES

ON A CONVEYORIZED PAINTING SYSTEM

PAINTING exterior and interior surfaces of metal containers on a production line basis can be a problem, especially if the vessels are made in various diameters and lengths and include recesses that can trap paint. This problem was faced by engineers of Westinghouse Electric Corp. when they were planning finishing facilities for a distribution transformer plant in Athens, Ga. What was desired was an automatic finishing system capable of handling steel transformer tanks, ranging in size from 12 to 22 inches in diameter and 20 to 48 inches in length, and miscellaneous parts at a line speed of 5 feet per minute. The system was to clean and surface treat parts with a phosphate coating and apply a 3-coat paint finish consisting of a primer containing corrosion inhibitors, an intermediate finish containing mica flakes, and a gray top coat that would prevent the passage of ultraviolet radiation.

The answer to the problem was provided by R. C. Mahon Co. who designed and manufactured the Athens plant finishing line shown in Fig. 1. Key to the success of the system is the application of paint by both spray and flow methods simultaneously. Flow coating is applied to vertical surfaces which can drain normally to provide a consistent paint film thickness. In recessed areas which form natural traps for flow coated applications, spray guns provide the painting means.

Transformer tanks are fabricated on one of the three major subassembly lines in the Athens plant.* As a final operation on the subassembly line, the completed tanks are inverted automatically so that the units are bottom up. The tanks are then moved by powered roller conveyor to the loading point of the cleaning and painting line where they are re-

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*For details, see "Fabricating Transformer Tanks," AUTOMATION, Vol. 6, No. 7, July 1959, p. 53.

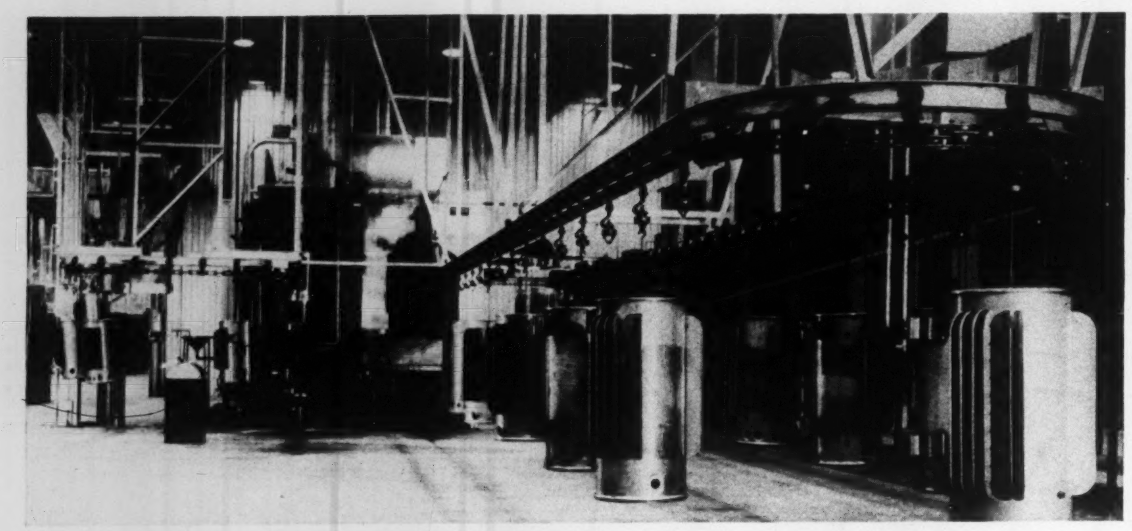


Fig. 2—Tanks are conveyed from the fabrication line, out of picture to the left, and enter washer. They then double back through a dryer and are conveyed to phosphate coating machine, large structure at right of picture. After drying, the tanks are conveyed into the enclosed painting room in the background, Fig. 4.

leased one-at-a-time onto an elevator unit. This device lifts each tank so that it can be hooked onto a 2600-foot long circulating conveyor system serving the finishing area. A small eyelet mounted in the center of each tank bottom provides a means for hooking the tanks to the conveyor.

The tanks are then conveyed to the surface preparation equipment, *Fig.* 2, at the start of the automatic finishing line. The units first pass through a spray washer where they are flooded with an emulsion-type alkaline cleaner, drained, and rinsed. The conveyor line then carries the tanks through a dry-off oven and a cooling zone to the first of four automatic flow coating machines.

▶ Coating Application

The four coating machines are similar in design and operation and in succession apply a phosphate wash primer, a prime paint coat, an intermediate paint coat, and a gray finish paint coat. Between each coating operation, the tanks are conveyed through an oven zone for drying or baking.

Each machine consists of a coating unit and a drain tunnel. As a tank enters the application zone of the coating unit, it is automatically rotated on its conveyor hook to obtain complete coverage of both exterior and interior surfaces. While in the application zone, two separate coating systems apply material to exterior surfaces of the tanks. Vertical surfaces are flooded by 16 nozzles, eight each on opposite sides of a tank, *Fig.* 3. The outside bottom of each tank is sprayed by two guns which are actuated as the conveyor hook enters the applica-

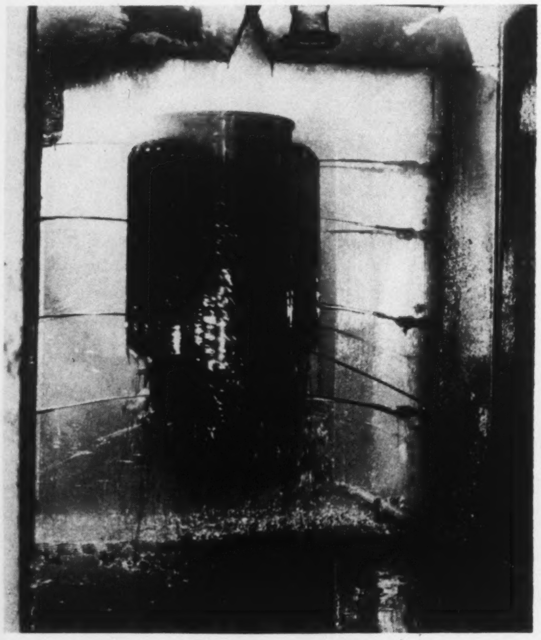


Fig. 3—This view shows the application zone of one of the coating machines. On each side of the tank are eight ¼-inch diameter copper tubes which act as nozzles for coating the outside vertical surfaces of the tank. The tubes can be bent to various positions for complete coverage of the different tank diameters and lengths. Not shown in this view are two spray guns for coating the top portion of the tank and a bottom nozzle for coating the interior of the tank.

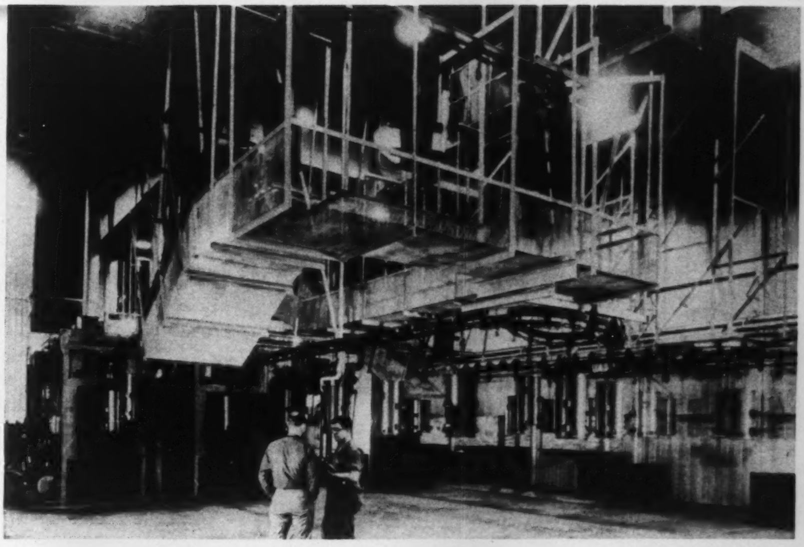


Fig. 4—View inside the paint room shows the entrances to the three painting machines. From right to left are the prime coat machine, the intermediate coat machine, and the final coat machine. The three-compartment baking oven is located on the roof of the building to the rear of the machines.

tion zone. Interior surfaces of the tanks are coated only in the first and fourth machines (phosphate primer and final paint coats). This is accomplished by a nozzle located beneath the tanks which sprays material upward into the units when they move directly over the nozzle. Height of this coating stream is controlled by a valve which can be adjusted to spray different length tanks.

After each coating application, the tanks pass through a drain tunnel where excess material drops from the tanks and is recovered for re-use. The tanks then are conveyed through either a dry-off oven or a bake oven before receiving the next coating application. A single oven is used after the phosphating operation, and this unit is located on the plant floor. After each painting operation, the tanks are conveyed up to a 90-foot long, three-compartment bake oven located on the roof of the plant. Location of the large bake oven on the plant roof provided considerable savings in production floor space and permitted all finishing operations to be confined to an area of approximately 50 by 240 feet. After the final paint coat is applied and baked, the tanks are conveyed to a final assembly area where cores and coils are installed in the tanks.

Paints and solvents used by the three painting machines are prepared separately in a volatile storage area outside the plant building and are pumped to two 250-gallon tanks at each machine. One tank holds the paint and the other tank holds the solvent. Materials in the paint tanks are continuously circulated to prevent settling. Since the paint temperature increases in pumping, a refrigerating unit is used to maintain the paint temperature at optimum flow coating level. Paint viscosity at each machine is automatically measured at 2-minute intervals, and solvent is added when required.

The preparation area outside the plant consists of 8 agitator-type tanks, each holding 125 gallons. The system is arranged so that a pump can draw from either of two tanks for pumping material to each machine. This allows paint to be pumped to one machine tank while solvent and paint are being properly mixed in the other tank.

are you stuck?

Since its inception Automation has helped increasingly in the solutions of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, if you have not as yet seen the answer to your need in the pages of Automation the Editors will be pleased to make special effort to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this reader service. Write to: The Editor, Automation, Penton Bldg., Cleveland 13, Ohio

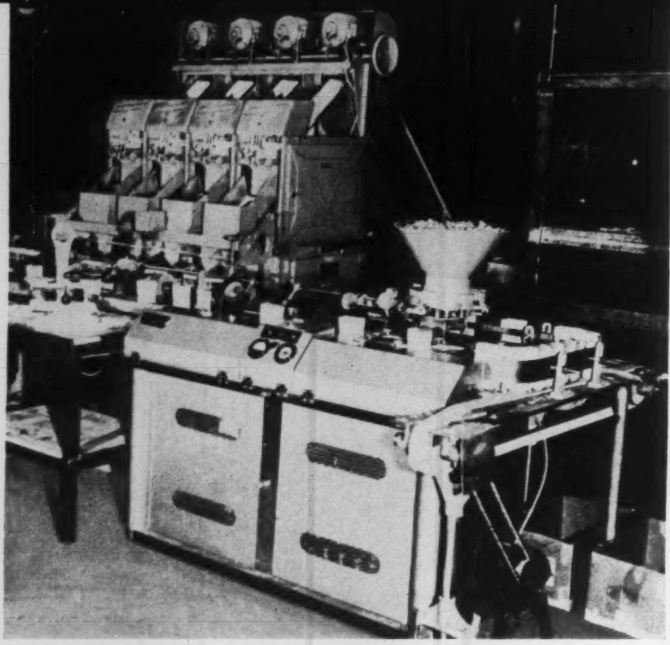


Fig. 1—Automatic checkweigher, manufactured by Exact Weight Scale Co., is installed in a packaging line at I. J. Grass Noodle Co. Noodles are placed in boxes by four-spout filler in background. A small tablet is then added from hopper, and filled boxes pass through the checkweigher from right to left. Checkweigher automatically rejects packages that are under or overweight, allowing only acceptable products to proceed to subsequent operations. Equipment of this type is suitable for a variety of products including automotive pistons, packaged foods, hardware, and ammunition.

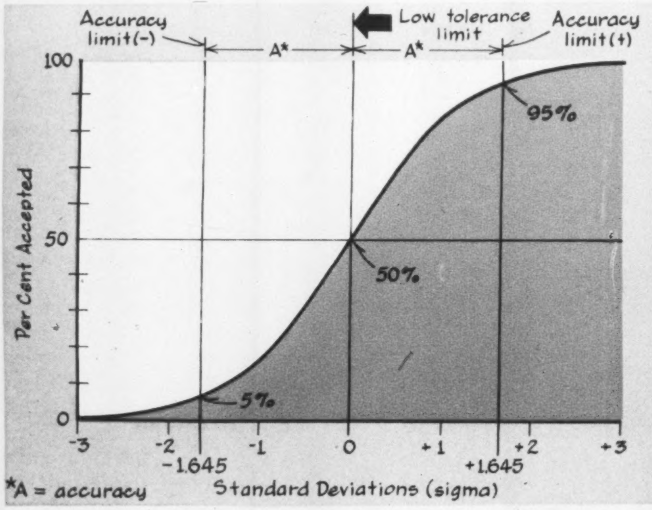
SELECTING AND APPLYING

HIGH SPEED CHECKWEIGHERS

Automatic checkweighers are performing usefully in many continuous production lines where discrete items must be weighed, classified, and sorted at high speeds. With accessory controls, checkweighers can also provide closed loop control of filling processes. Factors that should be considered in choosing a basic checkweigher and its controls are outlined in this article.

DEVELOPMENTS in automatic checkweighing have kept pace with industry demands for higher operating speeds to the extent that, today, equipment is available that can weigh, classify, and sort discrete items at rates from 50 to several hundred items per minute. Checkweigher controls have also evolved that can provide electrical feedback signals to automatically adjust the processing units supplying the items, so as to minimize the number of over or underweight items produced. Thus, modern checkweighers are useful automation components that can improve operations in many continuous production lines.

Typically, a high speed checkweigher might be placed in a processing line between a filling machine and a closure machine, *Fig.* 1. In this application, each product from the filling machine—such as a container filled with a liquid or a powder—is checked for conformity to weight standards and either passed to the closure machine or automatically shunted off



the main line. Product units that are shunted off the line because they are over or underweight may then be taken to a trimming station for correction of their fill weights. Thus, only a small percentage of the products, namely, the rejects, require manual handling.

In another type of application, automatic checkweighing equipment is used to control package counts on the basis of weight. For example, packages or assemblies of multiple units can be checkweighed to determine that each package or assembly contains a predetermined number of subunits. Packages of nuts, bolts, golf balls, and cartridges are often checked in this manner.

▸ Checkweigher Selection

Whatever the application, proper choice of a high speed, automatic checkweigher usually involves the consideration of a number of factors. For example, some of the variables that frequently have to be dealt with include: Shape, weight, and contour of the product or products to be handled; required speed of operation of the checkweigher; weighing accuracy required; weight tolerance for the product; and environment in which the equipment will be operated.

The shape, weight, and contour of a commodity to be checkweighed are important to the degree that they affect handling characteristics. Unusually bulky, heavy or light, or oddly shaped items can require severe reductions in speed in order to ensure accuracy of checkweighing. For, to secure maximum accuracy, it is necessary that the product units be transferred smoothly to and from the scale of the checkweigher, and that the units become a part of the weighing system during the available weighing time. Thus, products that tend to impart impact effects to the scale due to rocking or bouncing, or that become airborne above certain speeds, usually require reduced checkweigher speeds.

In some cases, a checkweigher can be equipped with special handling means and weight sensing devices so that an unusually difficult product can be checkweighed accurately at relatively high speeds. But the machine is then nonstandard, and may lose some of its flexibility. The decision to acquire such a machine then hinges upon the savings potential inherent in running that product at a higher speed, as opposed to the added cost of the special design features. If there are several products involved, the economical solution may be to checkweigh the difficult product at reduced speed on a standard machine.

Even when no difficult-to-handle products are involved, product variety can be an important factor affecting checkweighing speed and accuracy. For example, a machine designed to handle a 4 x 4 x 1-inch high, 6-ounce package, and nothing else, would be much faster and more accurate than a machine that must accommodate the variety of packages that are marketed in the average grocery store. Again, the relative economics of standard versus special machines would govern the choice and number of checkweighers to be used.

Required accuracy of a checkweigher has a profound effect upon the attainable speed, and the two characteristics should both be quoted in the machine specification. As an example of the effect of accuracy requirements upon speed, a checkweigher that is to detect one missing item in a carton of twelve (8.3 per cent error) can easily operate at a much faster rate than one which is to operate to fill tolerances of 1 or 2 per cent on packages of powdered food products.

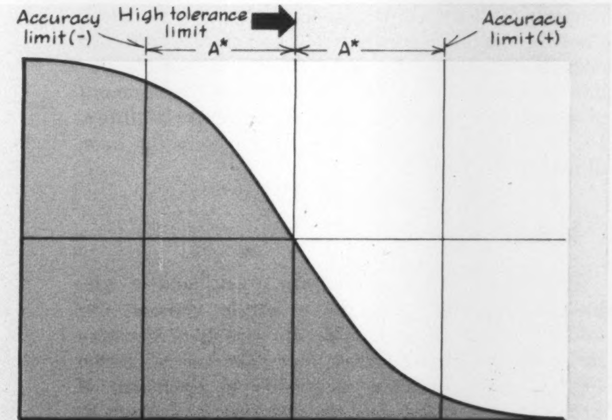


Fig. 2—Curve at left illustrates the relative probabilities of acceptance for packages of various weights falling near the low tolerance limit setting of a checkweigher. Abcissa values are given in terms of standard deviations rather than absolute weights so that the curve is applicable to any machine. For example, if the accuracy figure of any machine be taken at ±1.645 sigma points, that machine can be expected to erroneously accept 5 per cent of the packages whose weight falls at the minus accuracy limit. Likewise, 95 per cent of the packages corresponding in weight to the plus accuracy limit will be correctly accepted. These actions, of course, will occur whether the accuracy limits represent departures from the central point of 1, 2, or 10 grams, for example. Once a machine has been tested, specific weight values may be assigned to the sigma points, and an accuracy figure stated in terms of weight. Specification of accuracy at the ±1.645 sigma limits is common, since this ensures that most of the weights that can be classified inconsistently will be included between such limits, yet the product weight tolerance limits will not be restricted unduly. The righthand curve applies at the high tolerance limit setting of the checkweigher. Analysis for this curve is similar to that for the lefthand curve, except the probability of acceptance decreases as package weights approach and exceed the high tolerance limit.

Accuracy and Tolerance

A certain amount of confusion has always accompanied use of the terms "accuracy" and "tolerance" as applied to checkweighing. Perhaps the simplest explanation of the difference between the two terms is to state that accuracy relates to the degree of freedom from error of the checkweigher itself, and tolerance applies to the permissible total variation in weight of a given commodity. Thus, accuracy is a quality of a specific piece of checkweighing equipment, and tolerance is a product weight standard established by authority or producer convention.

Assume, for example, that a manufacturer wishes to produce packages which, when filled, weigh a nominal 500 grams. Realizing that it is an impossibility to hold each product unit to this exact weight, the manufacturer assigns a weight tolerance that will neither give reason for customer complaints of gross underweight nor result in uneconomical operation due to consistent overfilling of the cartons. His decision might take the form of setting tolerance limits of 495 and 505 grams for acceptable packages.

Ideally, this requires that the checkweigher be able to distinguish between packages weighing less than 495 grams from those that weigh 495 grams or more at the underweight limit, rejecting the lighter and accepting the heavier. At the overweight limit, the checkweigher is additionally required to accept packages weighing 505 grams or less and reject as overweight those packages weighing more than 505 grams. The implication in each case is that the checkweigher have what amounts to an impossibly high degree of accuracy. Therefore, another factor—the accuracy capability of the actual checkweighing equipment—must also be considered. Typically, this is of the order of 0.2 per cent of the package weight (or 1 gram) for an operation of the type being discussed.

Basic to an understanding of an accuracy figure for a checkweigher is recognition of the fact that, between the definite weight limits where good and bad products are properly classified, there lies a range where a given weight will sometimes be accepted and at other times be rejected. Accuracy, then, may be considered to be an expression of the range of weights that must be excluded because the checkweigher may classify them erroneously.

The "area of indecision" thus defined is common to all checkweighers (and precision instruments in general), and the decisions that are made between its confines have been found to conform to probability theory, *Fig.* 2. That is, the probability of acceptance of weights falling inside the accuracy limits is a function of their relative positions between those limits. As an example, a product having a weight equal to that represented by the midpoint of the curve of *Fig.* 2 will be accepted arbitrarily half the time it is presented and rejected half the time. On the other hand, a product weight that is closer to one accuracy limit than the other will more probably be classified as if it had the character of the weight represented by the nearer limit.

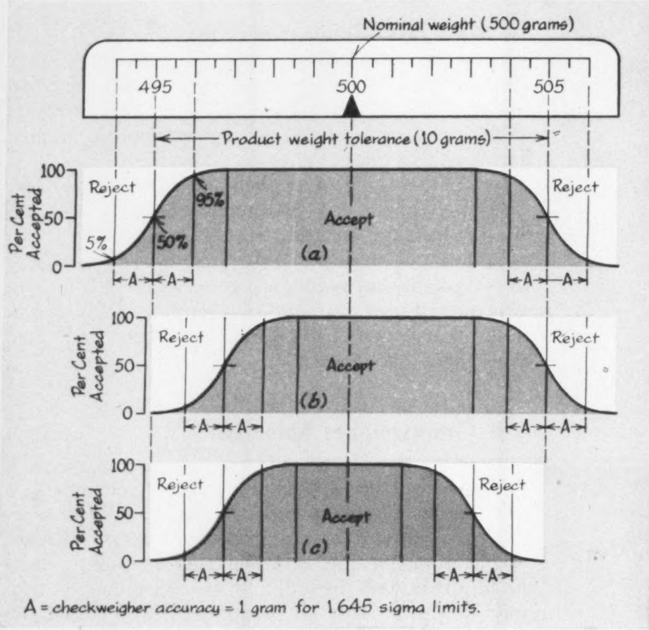


Fig. 3—Diagram illustrates typical checkweigher settings that might be made in an application where nominal product weight is 500 grams and weight tolerance is 10 grams. In order, settings (*a*), (*b*), and (*c*) ensure smaller probabilities that products falling outside tolerance limits will be erroneously accepted.

The curve of *Fig.* 2 will be recognized as the cumulative form of a normal distribution curve. However, an appreciation of the statistical basis for the curve is not necessary to an understanding of checkweigher accuracy, since a good analogy exists in the use of an ordinary micrometer. Assume, for example, that measurements are to be taken with a micrometer that has marks representing 0.001-inch gaging increments and that the readings are to be recorded to the nearest thousandth inch. It is obvious that an inspector is much more likely to properly classify dimensions falling near a mark than he is to consistently classify those that fall near the midpoint between marks. The contribution of statistical theory is to enable the assignment of numerical values to these intuitive probabilities. In this discussion, that contribution takes the form of the curve of *Fig.* 2.

Application Example

Returning to the case of the manufacturer who has decided that packages weighing between 495 and 505 grams are acceptable, the setting of tolerance limits on his checkweigher may take several forms, *Fig.* 3. Each example is predicated upon use of a checkweigher that has an accuracy of 1 gram at ±1.645 sigma points.

The manufacturer might decide to adjust his machine so that the central points of its cumulative probability curves fall at the selected tolerance limits of 495 and 505 grams, *Fig. 3a*. This, of course, will entail the risk that 5 per cent of the products weighing exactly 494 and 506 grams will be erroneously accepted as good. However, if the process itself is well controlled, the over-all risk of either courting customer dissatisfaction or operating uneconomically is slight, since only a small percentage of the products presented to the checkweigher will normally be found near the tolerance limits.

A checkweigher setting as in *Fig. 3b* might be adopted where government or customer specifications call for virtually no underweight products. In this case the underweight setting of the checkweigher is moved so that the -3 sigma point on the curve falls at the 495 gram limit. This ensures that, in the long run, only a negligible quantity of the products weighing less than 495 grams will be accepted by the checkweigher. Even greater assurance that no underweights will be passed may be obtained by moving the curve further inside the low tolerance limit. However, it should be realized that the slope of the curve in the region of its -3 sigma point is so small that very little is to be gained by further displacing the curve in this direction.

The machine adjustment exemplified in *Fig.* 3c is one in which the central points of both end curves have been moved inside the weight tolerance limits. The purpose of such an adjustment might be to provide early detection of changes in the process that tend to cause excessive rejects for either over or underweight.

▶ Effects of Environment

The environment in which a checkweigher and its controls are operated has an important effect upon performance. In practice, all sorts of environments are found ranging from clean, dry locations to those in which extreme heat, water, steam, dust, or moisture are present.

Aside from its direct effect on the equipment, a poor environment can cause additional trouble by changing the product density and handling characteristics. Thus, to obtain full advantage of the capabilities of a checkweigher, and to prolong its useful life, the user should provide the best environment that conditions allow.

If this environment is not an ideal one, servicing and maintenance may have to be performed at frequent intervals. A regular program for these routines should then be set up and rigidly observed.

▶ Indicators and Controls

Checkweighers can be equipped with a variety of indicators and controls that can facilitate operations in a number of ways. In their simplest form, such devices total the number of good, overweight, and underweight products that are classified in a given time period. Signal lights may also be provided to visually indicate the routing of each item in a run.

More sophisticated controls can shut down the process, actuate alarms, or automatically adjust the line equipment when excessive rejects occur. For example, devices are available that will stop the line or sound a warning when a predetermined number of products (such as 3 out of 10) is rejected.

Where desired, controls may be used that can continuously monitor and record checkweigher performance and, in some cases, provide corrective signals to compensate for process changes. The control console in *Fig.* 4, for example, has chart recorders on which averages and ranges are plotted. Each point on a chart represents a computation based on a sample of 10 consecutive packages. The console has the additional ability to provide output signals to processing equipment such as a filling machine. Operation is such that, when a test weight average exceeds preset limits, corrective signals will be generated to bring the average fill weight back in line. The plot of range data is useful in warning of excessive spread in package weights. Accessory signal lights may be included to provide visual indications of the latter condition.

Understanding of the capabilities of automatic checkweighers and their controls will suggest other industrial applications in which these components can cut costs and improve quality. With feedback control of line equipment, product weights or counts may be controlled automatically without the need for constant operator attention or frequent manual adjustment.

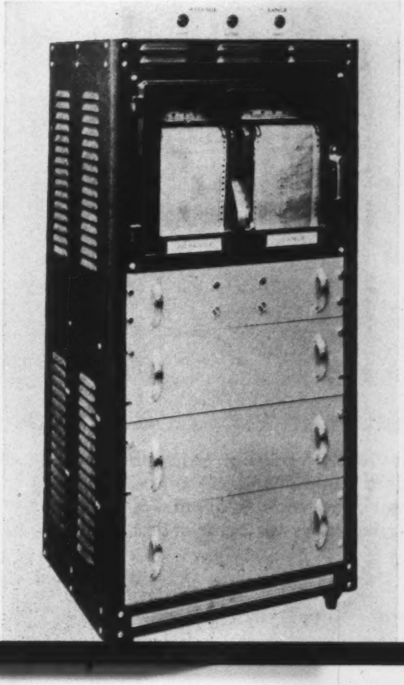


Fig. 4—Control console developed by Exact Weight Scale Co. continuously accumulates weight data from a checkweigher and supplies corrective signals to adjust process equipment if serious average weight shifts occur. Chart recorders plot average and range points for each group of ten consecutive products classified by the checkweigher.

PROGRAMMED SKIP-PUNCHING

PERFORATES VARIETY OF BLANKS

Continuously cycling press with skip-punching device is controlled by an automatic programming counter. A desired pattern of punching and skipping is set up by placement of pins in a program cylinder which is part of the counter.

SOUND-DISPERSING tubes for automotive mufflers are used in large quantities and are required in various hole patterns. Since such tubes are manufactured by many efficient competitors, improved methods for their fabrication are continually sought. Saco-Lowell Automotive Div., Saco-Lowell Shops, is using two automatic lines, *Fig.* 1, to produce perforated flat blanks for sound-dispersing tubes. Flat steel coil stock is fed into each line; blanks for individual tubes, perforated according to selected patterns and cut off to desired lengths, are ejected from the line.

In each line, the perforating work is performed

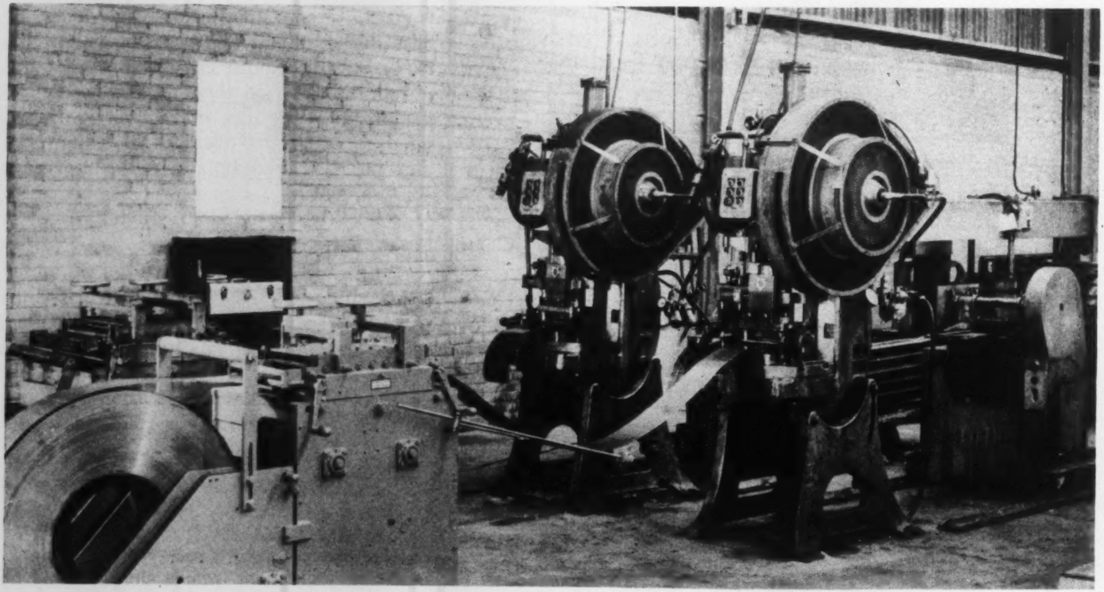


Fig. 1—Two compact lines arranged side by side receive coils of strip stock and automatically produce blanks perforated in a desired pattern and cut off to proper length. One operator handles both lines, and total production is about 750 pieces per hour. The blanks are used to make sound-dispersing tubes for automotive mufflers.

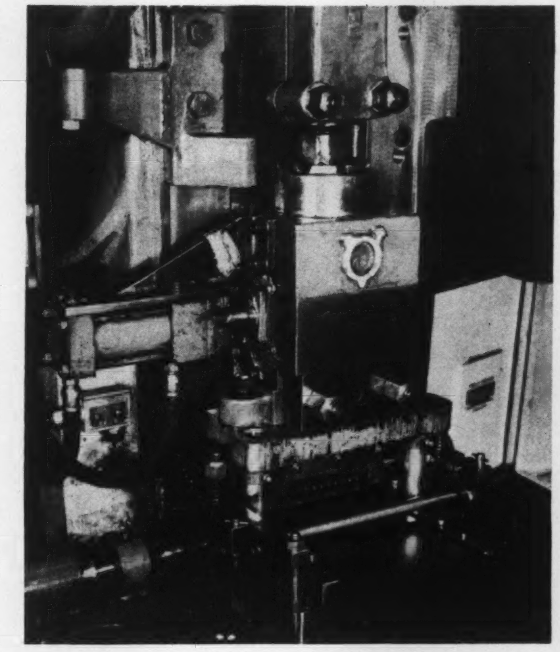


Fig. 2—Closeup of the front of one of the presses shows the skip-punching device built into the slide of the press. The double-acting air cylinder in the skip-punching device positions a cam that can allow the press crankshaft to cycle without work being done on the blank stock. This versatile arrangement was originally developed by Embart Mfg. Co. for another application of their V&O presses.

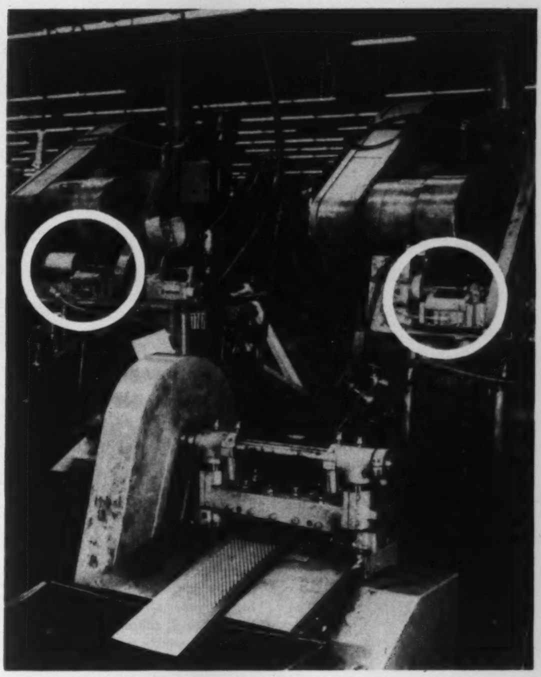


Fig. 3—View looking toward camera position for *Fig.* 1 shows cutoff machine for one line in the foreground. Circled areas on the backs of the presses indicate the programmed counters which control the punching and skipping cycles of their respective presses. Additional counter unit, visible on left press and directly to right of the skip control unit, automatically cycles the cutter in that line.

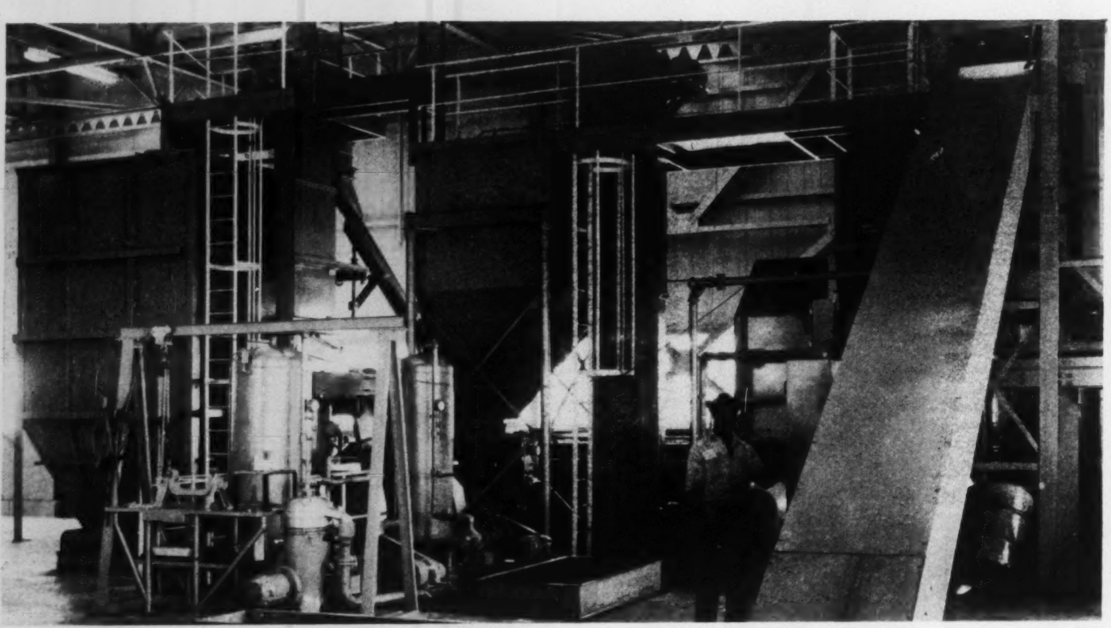
by a V & O Press built by the Hudson Div., Emhart Mfg. Co. During operation of a line, coil stock is intermittently advanced through its press a preset distance for each revolution of the press crankshaft. Under normal operation the crankshaft rotates continuously at an essentially constant speed of 250 rpm. Therefore, the stock is moved through the press at a constant rate of 250 indexes per minute. However, the slide of the press includes a skip-punching device, *Fig.* 2, which can be selectively actuated to prevent perforating of the stock even though the press crankshaft cycles.

The skip-punching device built into the press slide includes two fixed-type cams and a third cam which can be moved to either one of two positions by a double-acting air cylinder. When the stock is not to be perforated on a given cycle of the crankshaft, the air cylinder shifts the movable cam and positions the punch member in the slide in such a manner that it does not contact the stock. For those cycles on which the stock is to be perforated, the movable cam is shifted to a position such that the punch does work on the stock.

A pattern of spaces and perforations for a given blank is programmed by proper placing of switch pins in the program cylinder of a circuit controlling counter with automatic recycling. This counter, manufactured by Counter & Control Corp., is mounted on the back of the press it controls, *Fig.* 3, and is driven in time with the press crankshaft. Arrival of a program pin at a control point is sensed by an electric switch which causes an air valve to shift the air supply to the cylinder accordingly.

The strip of properly perforated stock feeds from the punch press to a cutter built by O'Neil-Irwin Mfg. Co. The cutting operation is performed automatically under the control of a preset counter which is also driven in time with the press crankshaft. After the completed blanks are cut off, they drop into a tote bin for movement to subsequent operations.

The skip-punching device adopted for this perforating operation was originally devised at Emhart Mfg. Co. for use on notching machines to produce the slot patterns in electric motor rotor and stator laminations. Its principle of programming repetitive patterns of punching and skipping was recognized by Saco-Lowell methods engineers as being applicable to the project. Net result was a method that is basically simple and uses tooling much less costly than would have been required by other techniques considered.

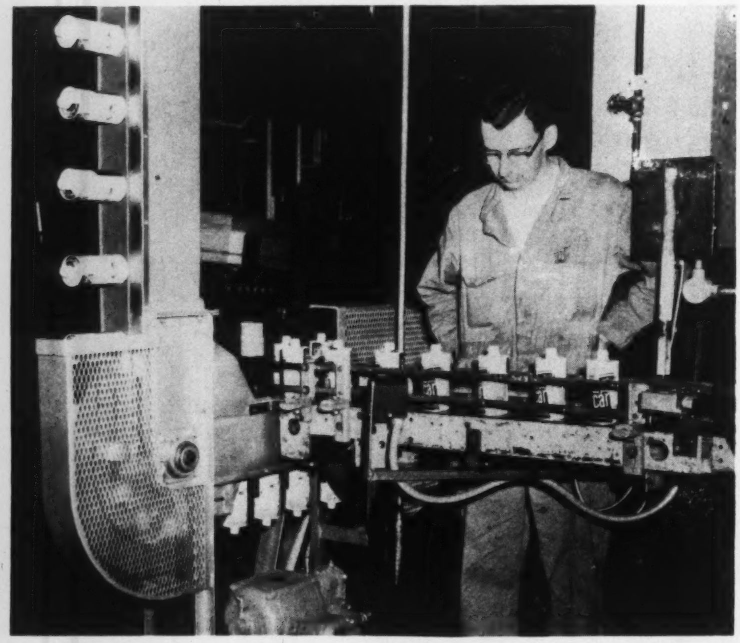


Processing Metal Chips

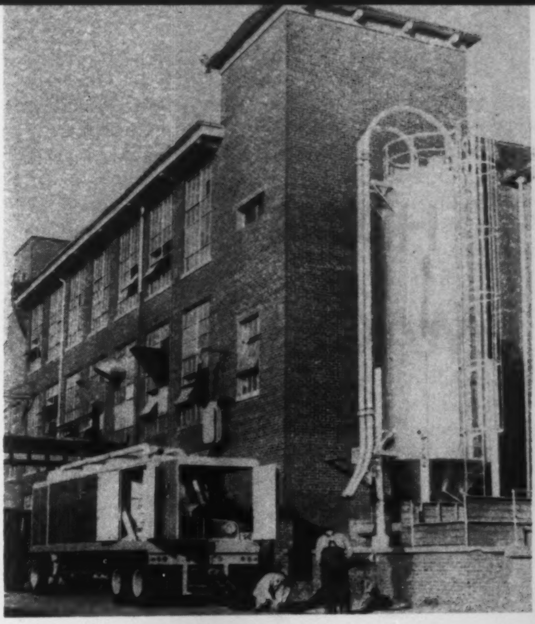
CONTINUOUS metal chip handling and cutting oil recovery system has been installed in a new bearing plant of Link-Belt Co. in Indianapolis, Ind. The process was acquired from Turbine Equipment Co. as an addition to Link-Belt's line of materials handling and processing equipment. Turnings are moved up the inclined conveyor to a work separator where large pieces of metal stock are removed. They are then fed into a surge hopper above a crusher, crushed into uniform size chips, and transported to a wet chip storage bin (center of system) by screw conveyor and bucket elevator. Chips are withdrawn from bin by a screw feeder and automatically loaded into extractor. After being spun to remove cutting oil, chips are screw fed into another bucket elevator and lifted into dry storage bin at left of system. When loading a gondola car behind system, chips are withdrawn from bin by screw feeder and fed into the bucket elevator which originally loaded dry storage bin. Flop gate at top of elevator directs chips into car.

Handling Cans

CONSERVING production floor space is a task that all manufacturing engineers are concerned with. An example of how one company solved this problem is this magnetic handling application at S. C. Johnson & Son Inc. in Racine, Wis. To make room for additional automated equipment, can storage for Johnson's Wax products was moved to an upper floor along with can dumping and unscrambling equipment. Empty cans are conveyed from the upper floor to a filling machine on the production floor by means of the magnetic conveyor system shown. Magnetic units installed behind a moving belt secure the cans during the vertical descent. Magnetic rolls hold the cans during a 90-degree turn and a second 180-degree turn. The cans are then picked up and conveyed by the feeding system of the filling machine. All magnetic components were furnished by Eriez Mfg. Co.

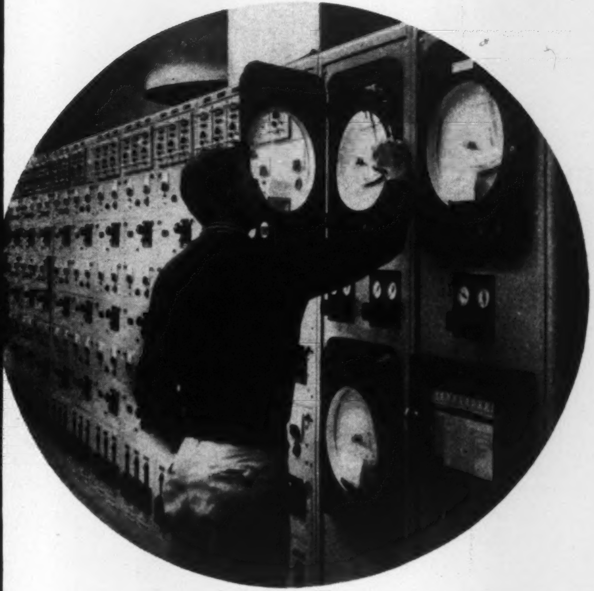


in action



Mobile Bulk Handling

PNEUMATIC bulk handling trailer manufactured by Fuller Co. is used by Springs Cotton Mills to replace manual bag-handling operations for starch. Starch is now delivered to a railroad siding in 60,000-pound hopper cars. The cars are unloaded by coupling them to the bulk trailer with flexible rubber hose and starting the engine and blowers in the rear compartment of the trailer. When the trailer capacity of 25,000 pounds has been loaded, the unit is uncoupled and driven to one of seven Springs Cotton Mills. Two pipeline connections are made at a mill. One provides for material delivery, and the second allows dust-laden air to recirculate to a filter installed in the trailer, eliminating the necessity for a dust collector at each mill. Bulk starch is stored at the mills in either exterior silos or in horizontal bins installed near size preparation rooms. The new system has resulted in a starch cost reduction of 22 cents per 100 pounds under the bagged price.



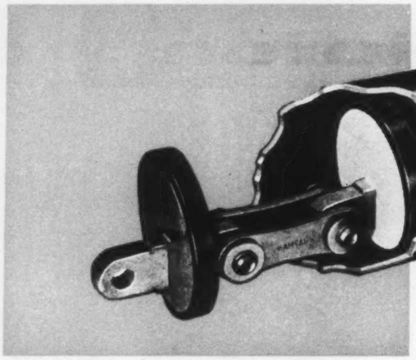
Controlling Fiber Glass Yarn

THICKNESS of fiber glass yarn is determined by the temperature of platinum bushings through which molten glass is drawn at high speeds. At the Shelby, N. C., plant of Pittsburgh Plate Glass Co., 240 electronic temperature controllers manufactured by Hagan Chemicals & Controls Inc. maintain individual bushing temperatures at 2200 F, plus or minus 0.25 F. The controllers are grouped in four large instrument panels (one panel is shown in this view), and each instrument is responsive to thermocouple fluctuations of one microvolt. The drawn glass fiber is so fine that a continuous single strand weighing one pound would measure 1700 miles in length.

Cleaning Castings

GRAY iron and nonferrous castings are cleaned in approximately 8 minutes in this Pangborn Corp. Rotoblast barrel machine installed at Canadian Westinghouse Corp. in Hamilton, Ontario, Canada. The 27-cubic foot capacity machine will handle loads averaging 2500 pounds which consist of parts up to 2 foot square in size. The machine loader on the right is filled to a preset weight by an oscillating conveyor. During this time, the machine blast cleans the previous load and automatically discharges cleaned castings onto the take-away conveyor moving to the left. When the barrel is empty, the loader moves up the track and dumps a new load into the machine. The system cleans approximately 280 tons of castings each month.

HANDLING MACHINING WASTES



WITH TUBULAR CONVEYOR SYSTEMS

EVER-INCREASING production rates of machine tools and other manufacturing equipment, so vital to progress in industry, can force similar speedups of related functions. One of the functions that can be so affected is that of removing from work areas the byproducts of manufacturing operations such as chips, dusts, and sludges.

Automation itself can accelerate the need for efficient byproduct removal in two major ways. First, it can lead to adoption of multioperation, multistation machines that generate large amounts of wastes, very rapidly, in localized places. Secondly, a basic tenet of automation—integration of operations—implies use of efficient work performing, handling, and control means whereby more parts per hour can be passed through an over-all process.

Two Types of Systems

Continuous chip removal systems are of two general types: Unitized and centralized. With a unitized system, each machine is equipped with its own chip collecting arrangement that conveys chips and scrap generated by that machine to an individual tote bin or other container. In a centralized system, all chips generated in an entire manufacturing area are delivered to a common collection point by feeder lines from each machine.

The choice between a unitized and a centralized installation for a given department or plant depends primarily upon two factors—the capacity of each machine to produce chips and the layout of the factory. For example, if the machines that produce large quantities of chips are scattered throughout the plant, it is normally more economical to have individual units for each machine. Unitized systems are also the rule when the factory is laid out with large work aisles so that fork trucks have easy access to chip tote containers.

However, if a number of machines are confined in a relatively small area within a department, and each machine has only a small capacity for producing chips, the centralized system will usually be more economical. One conveyor, mounted below floor level, can then service all of the machines and convey the chips to a central collection point.

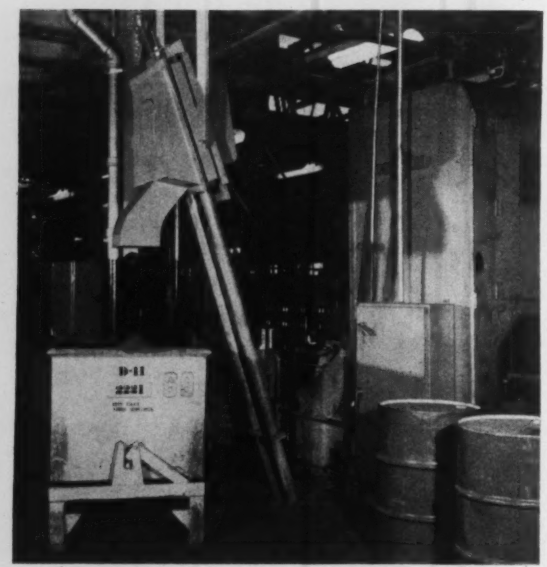


Fig. 1—Dry chips, produced in broaching machine at right, are automatically collected and dumped into tote bin by tubular conveyor system. Assembly containing discharge chute is a combination 180-degree drive and chain-tensioning unit. Tensioning is effected by moving assembly to proper position along tubes projecting from floor. System capacity is 800 pounds of dry chips per hour using 3-inch pipe and 10 fpm internal chain speed.

If a complete process includes a large number of machines producing considerable quantities of chips, with limited aisle space for maneuvering of fork or hand trucks, a special type of centralized chip removal system may be needed. With this system, a conveyor mounted at each machine elevates the chips from that machine and deposits them on a common conveyor traveling just below the roof trusses of the building. The common conveyor then delivers all of the chips to a collecting point.

▶ Major Installation

At the Motor Truck Div., International Harvester Co., both unitized and centralized chip conveyor systems are used in a manufacturing area for V-8 engines. The conveyors are a tubular type manufactured by Hapman Conveyors Inc. Each conveyor includes a system of piping, shaped to suit the application, through which an endless chain circulates continuously. Selective openings in the piping system permit the introduction of chips and scrap, while other openings permit dumping. Attached at regular intervals to the circulating chain are flights, or discs, that engage and move the materials through the piping.

An example of a unitized chip conveyor system used in the plant is shown in *Fig.* 1. In this installation, a tubular conveyor collects dry chips produced in a broaching machine and discharges them automatically to a tote bin. The conveyor was specified as original equipment by the machine tool manufacturer, Colonial Broach Co. In other cases, International Harvester personnel installed chip conveyors on existing equipment. These conveyors were fabricated from standard pipe sections, drive units, inlet troughs, and other off-the-shelf components.

A company-installed chip conveyor is illustrated in *Fig.* 2. This unit, which services a six-station dial indexing machine built by Cross Co., handles a wet mixture of chips and coolant. In order to reclaim the coolant for re-use, the initial section of conveyor pipe leaving the machine was made nearly vertical. This enables the coolant to drain to a sump below the floor. Clearances between the flights and the wall of the pipe facilitate the separation process. The coolant collected in the sump is pumped back to the machine and relatively dry chips proceed to a tote bin.

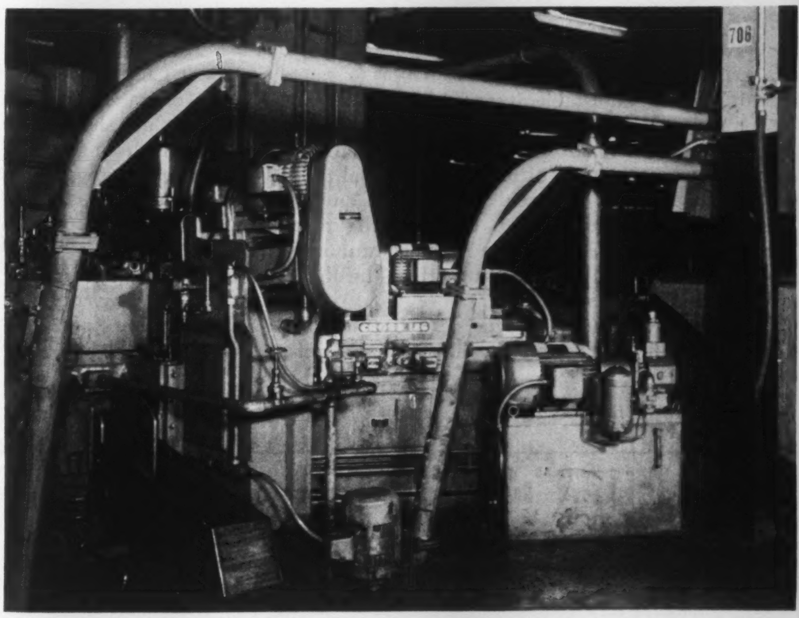


Fig. 2—Chip conveyor serving multistation dial indexing machine collects wet mixture of chips and coolant and discharges chips to bin behind column. Coolant drains to sump under floor as mixture is lifted vertically inside conveyor pipe. Motor shown projecting from floor drives a sump pump that returns coolant to machine.

▶ Design Data

Capacity of a given tubular conveyor is a function of pipe size and chain speed, *Fig.* 3. For chip conveying applications, pipe sizes from 2 to 6 inches are usually adequate. Because chips are highly abrasive, chain speeds are normally limited to a maximum of 20 fpm. Thus, from the chart, maximum usable capacity (at 20 fpm) for a 2-inch pipe system is 0.3 cfm; for a 6-inch pipe system this capacity is 3 cfm. Pipe sizes and chain speeds that satisfy other capacity requirements are readily found by reference to the chart.

To ensure positive discharge of conveyed materials that tend to cling to the chain or flights, a mechanical vibrator may be installed over each discharge opening in a system. The vibrator can be

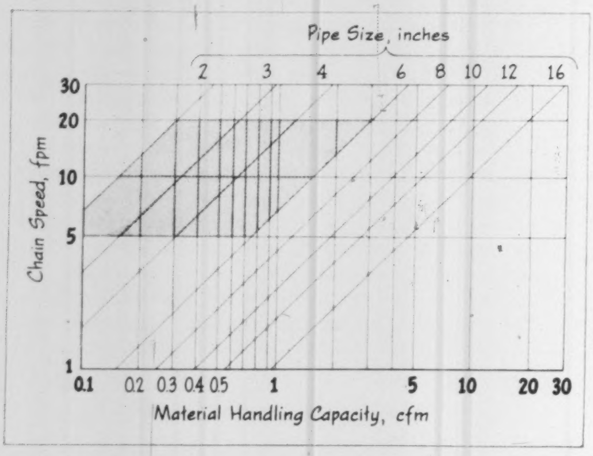


Fig. 3—Chart shows material handling capacities of tubular conveyor systems employing various standard pipe sizes and operated at different chain speeds. Systems falling within shaded area satisfy most continuous chip removal requirements.

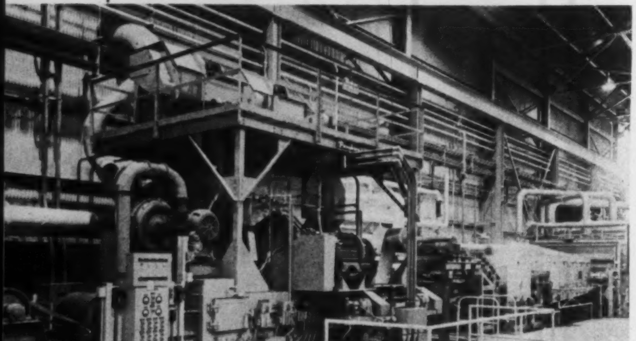
of a type that employs an electric motor to rotate a shaft having adjustable, eccentric weights. The shaft is mounted on the free end of a cantilever plate that vibrates with an amplitude proportional to the amount of unbalance of the shaft. A metal piece, called a knocker, is operated inside the conveyor pipe through a connection to the vibrating plate. The knocker strikes at least one flight continuously, causing conveyed material to drop off as the flights pass the discharge opening.

Tubular conveyors of the type described are suitable for handling a variety of materials and mixtures. Chips of steel, cast iron, and aluminum—both dry and mixed with coolants—are easily handled, as are sludges from quenching tanks and abrasive dusts from grinders.

Direct savings in material handling labor and in reduced machine downtime can frequently repay the cost of a chip handling system in a relatively short time. Although dollar values cannot usually be assigned to them, the additional benefits of improved housekeeping and less distraction for machine operators should be considered in determining the feasibility of such a system.

shot blaster processes parallel strips

SIMULTANEOUS descaling of both sides of two stainless steel strips is accomplished on a continuous production basis with shot blast equipment developed by Pangborn Corp. Installed in a continuous annealing and pickling line at the Coshocton, Ohio, plant of Universal-Cyclops Steel Co., the shot blast equipment can process both 300 and 400-series stainless steel strips, 0.040-inch or more thick, at speeds up to 80 fpm.



In operation of the line, coils of stainless steel strip, received from other plants, are placed in two uncoilers at the head end. From its uncoiler, each strip is fed progressively through a rolling mill, an annealing furnace, a fog cooler, and the shot blast unit. In the shot blast unit, both sides of the strip are descaled prior to the final line operations of pickling, inspecting, and recoiling.

To provide the necessary flexibility of operation of the shot blast equipment in this application, two blasting heads—each including an upper and lower blast wheel—are used. Each blasting head can be positioned laterally with respect to its assigned strip, and the velocity and volume of abrasive thrown by each blast wheel are adjustable. These features, and independent feed control for each strip, permit parallel coils to be processed simultaneously at different line speeds.

Other design features of the shot blast equipment include: A cleaning and recirculating provision whereby the steel shot can be re-used; and a 12,540 cfm dust collector system to clear the machine and surrounding areas of dust generated in the descaling operation.

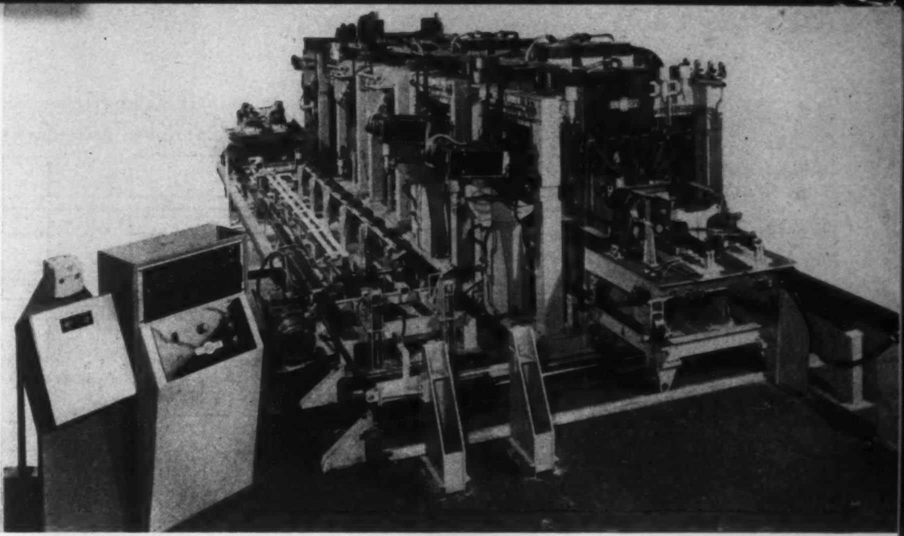


Fig. 1 — Automatically controlled 5-station welding machine is used to fabricate front subframes for a new line of British small cars. Twelve subframe parts are loaded into fixtures mounted on a transfer carriage which is shown ready to enter welding line at the right of the picture. System is capable of making over 300 spot welds on each subframe in approximately 75 seconds. Master control panel for the system is shown at the lower left.

FIVE-STATION MACHINE WELDS COMPLEX ASSEMBLY

Extra spot welds are often added to a complex part assembly to provide a safety factor for manual welding techniques. Automatically controlled welding machines can provide a qualitative means of eliminating a large percentage of these "safety factor" welds. This case study shows how one British manufacturer reduced the number of welds per assembly by 400 per cent through use of automated equipment.

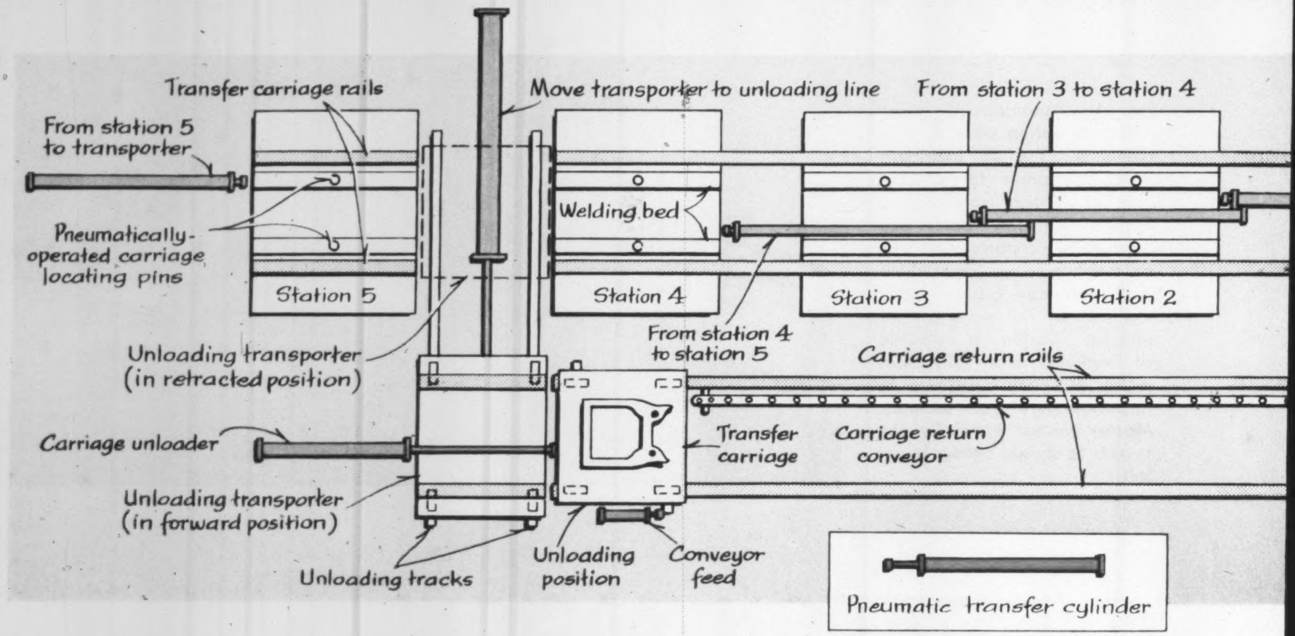
NEW PRODUCTS are usually ideal stimuli for investigating new methods and equipment that can be used in manufacture of the products. The manufacturing engineers are not confined to merely modifying an existing production line for the sake of economy but have free license to conduct feasibility studies to develop the best method of manufacture incorporating the latest developments in tools and equipment. Often these feasibility studies produce results that would have been rejected as being "unthinkable" if they had been proposed during the design of the product.

An example of this change in thinking occurred during the design of facilities for producing two new low-cost family cars, the Morris MiniMinor and the Austin 7, at British Motor Corp. Ltd. The new cars have a front wheel drive with independent springing on all four wheels and an engine transversely mounted in the front. All major mechanical components are mounted on two subframes, one at the front and one at the rear, which are then joined to a welded steel body having an integral chassis construction.

The job of fabricating the front subframe was given to Rubery, Owen & Co. Ltd. This component consisted of 12 separate steel parts varying in thickness from 16 to 10 gage and was originally designed to be welded with over 500 spot welds. Proposed planning schedules called for fabrication of 3000 subframes per 40 hour week. Sciaky Electric Welding Machines Ltd. was requested to design and manufacture equipment to perform the welding operation.

▶ Feasibility Study

A feasibility study of possible ways to fabricate the front subframe developed four methods of manufacture. Primary considerations in this study were


Transfer carriage rails
Move transporter to unloading line
From station 3 to station 4
From station 5 to transporter
Welding bed
Pneumatically-operated carriage locating pins
Station 5
Station 4
Station 3
Station 2
From station 4 to station 5
Unloading transporter (in retracted position)
Carriage return rails
Carriage unloader
Transfer carriage
Carriage return conveyor
Unloading transporter (in forward position)
Unloading tracks
Unloading position
Conveyor feed
Pneumatic transfer cylinder

the planned production rate of 3000 units per week and the necessity of producing a sound weldment having full strength spot welds. Secondary considerations of importance were the amount of labor required to operate the proposed machine and the ease of maintenance.

An arrangement using a single station welding machine was proposed and discarded since it required the employment of a large number of welding guns in a very limited area around the subframe. Besides being a complicated machine to design, a single station machine would have been difficult to maintain due to the close proximity of guns to each other.

Another arrangement was discussed whereby a bank of portable spot welding guns, pedestal spot welders, and projection welders would be used. However, evaluation of this proposal showed that approximately 30 operators would have been required to make an estimated 520 welds on the subframe component in order to meet the desired output figure. This proposal led to a third possible method which called for the use of a manually-operated trolley system between banks of portable guns and projection welders. The third proposal would have required about 15 men. However, this was still considered as having too high a labor content.

At this point the design of the subframe was reconsidered to see if some of the 520 welds could be eliminated. It was decided that if each welding point was accurately and squarely lined up with an electrode and direct rather than series welding was used, it would be possible to get a sounder, more dependable weld which could be assigned a higher strength value in an over-all evaluation of the strength of the weldment. By judiciously realigning the weld points in accordance with the revised weld strength values, approximately 200 welds were eliminated from the subframe assembly. However, it was realized that the reduced number of welds required the use of a properly fixtured automatic welding machine in order to maintain consistent welding of high quality.

▶ Machine Operation

Based on the design criteria established in the subframe redesign, Sciaky Electric Welding developed the 5-station electronically controlled welding machine shown in *Fig.* 1. The 12 steel stampings are assembled on transfer carriages at a loading station and are transported to each of the five welding stations in turn. Output of the machine is approximately 48 subframes per hour using two operators, one loading parts into the carriage fixtures and the other unloading completed subframes. This output is based on using only two transfer carriages at a time. That is, while one carriage is being progressed through the five stations, the other carriage is being unloaded and then loaded with parts for a subsequent component. However, the machine is capable of handling five transfer carriages at one time, and with additional operators the output can be increased proportionally.

As shown in *Fig.* 2, an extensive pneumatic system is used to move the fixtured parts through the 5-station welding machine. Parts are normally loaded onto the transfer carriage at the second loading position. The first loading position is provided for times when increased production is required, and two operators are used for loading parts. Each transfer carriage is 4 feet wide by 3 feet long and holds an assortment of jigs, back-up electrodes, holders, and current-carrying pressure pads. At the first loading station, the four-wheeled carriage is sitting on a four-wheeled loading trans-

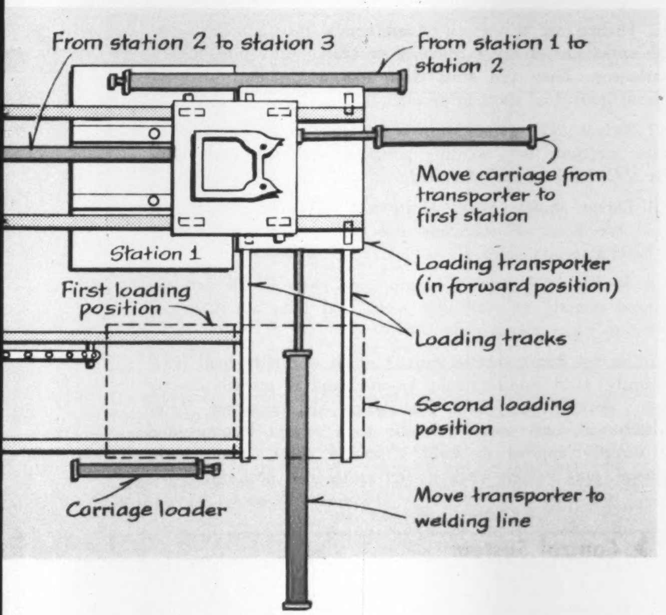

From station 2 to station 3
From station 1 to station 2
Move carriage from transporter to first station
Station 1
First loading position
Loading transporter (in forward position)
Loading tracks
Second loading position
Carriage loader
Move transporter to welding line

Fig. 2—Diagram illustrates the extensive use of pneumatic cylinders in the system. Parts are loaded onto the transfer carriage in either the 1st or 2nd loading position at the lower right of diagram. Operator then presses two pushbuttons, and carriage is automatically sequenced through the five welding stations and back to unloading position at lower left of diagram. Pneumatic cylinders are used to clamp parts into the transfer carriage fixtures, to move the carriage into and out of the welding line, to index the carriage between welding stations, to raise and lower carriage locking pins in each station, to move the carriage onto and off the transporters, and to feed the carriage to the carriage return conveyor.

porter which moves the transfer carriage to a position opposite the first welding station.

The 12 component parts of the subframe are secured to the transfer carriage by quick-acting, pneumatically operated clamps. The loading operator then presses two pushbuttons on the master control panel at his position. From this point forward, the machine sequence is automatically controlled until the welded assembly reaches the unloading position. A floor-mounted pneumatic cylinder pushes the loading transporter along tracks to a position in line with the first welding station, *Fig. 3*. At this point, the first pneumatic transfer cylinder is actuated and pushes the transfer carriage off the loading transporter and onto the carriage rails leading through the machine. The transporter then automatically retracts to the second loading position.

In the first welding station, the carriage is pushed against pneumatically raised stops which roughly position the carriage. Accurate positioning of the carriage is provided by two pneumatically operated locating pins which rise out of each station welding bed and lock into holes in the bottom of the carriage. The carriage rails then lower and deposit the carriage onto the welding bed. Various welding guns and pressure pickup pads automatically move into predetermined positions on the subframe and close, squeeze, weld once, weld again, and hold. In most cases, the welding sequence of the guns is repeated three times. At the conclusion of this cycle, some of the guns automatically move to a second welding position and repeat the triple welding sequence at the new spot.

When welding at the first station is completed, the guns and pressure pickup pads retract, the carriage rails are lifted into position, the locating pins are withdrawn into the welding bed, and the carriage stops are dropped. The master control panel actuates the second transfer cylinder, and the transfer carriage is automatically moved from the first to the second station where a similar locating, positioning, and welding sequence occurs. This action is repeated at the next two stations.

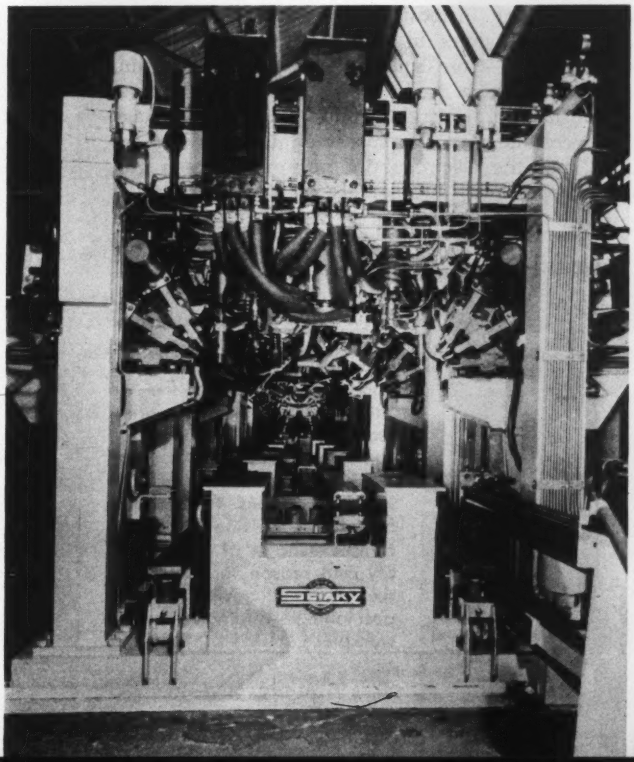


Fig. 3—End view of the welding line shows the line of travel for the transfer carriage from the first to the fifth station. U-shaped members in the center of the machine are individual welding beds for each station. On each side of the beds can be seen the rails on which the carriage is transported from station to station. When the carriage is in position in a station, the rails are lowered to deposit the carriage on the welding bed. Visible within the U-shaped openings of the beds are three of the pneumatic transfer cylinders. Located over the welding beds are the complex of welding guns which automatically position on various parts of the subframe to perform spot welding.

The fifth welding station requires a different sequence since the transfer carriage must enter and leave the station from the same end due to a complex welding operation on one end of the subframe. Before the carriage can be moved from the fourth station, the unloading transporter (similar in operation to the loading transporter) must be in its retracted position. The fifth transfer cylinder then pushes the transfer carriage across the unloading transporter and into the fifth station. After the welding operations are completed, the sixth transfer cylinder moves the carriage back onto the unloading transporter. Spring-loaded button locators lock into the locating holes in the bottom of the carriage to steady the unit as the unloading transporter cylinder pushes the unloading transporter and transfer carriage out of the welding line and to the carriage return line of the machine.

Two positions are available for unloading the completed subframe from the transfer carriage fixture. One position is shown in *Fig.* 4 and is at the end of the unloading transporter track. The transfer carriage is pneumatically pushed off the unloading transporter into the normal unloading position. As soon as the part is unloaded from the fixture, the unloading operator presses a pushbutton. This actuates a pneumatic cylinder which moves the transfer carriage into contact with a chain conveyor for movement to the first loading position. If this loading position is not being used, a closed circuit automatically actuates a pneumatic cylinder to immediately move the carriage onto the loading transporter.

▶ Welding Guns

The complexity of the subframe assembly can be seen in the accompanying illustrations, particularly in *Fig.* 4. For this reason, various arrangements of welding guns are required to reach all of the welding points on the subassembly. Each welding station uses combinations of the following gun arrangements:

1. **Direct guns.** Units are normally held directly above the workpiece, and electrode is advanced to weld one spot on the subframe.
2. **Hi-lift fan "C" guns.** Several guns are mounted on a fixture which advances the units in close proximity to the workpiece. Then the guns close like a C-clamp to weld several individual spots in parallel.
3. **Swivel "C" guns.** Gun is rotated about an axis to bring electrode into welding position, and then gun closes like a C-clamp to perform weld.
4. **Direct shuffle guns.** Units are advanced directly to weld one point on subframe and then are moved laterally to weld a second point.
5. **Shuffle "C" guns.** C-clamp type guns which are advanced directly to make one weld, and then are advanced again to make second weld.
6. **Swivel direct shuffle guns.** Unit is normally held horizontally. Gun rotates about an axis and is moved directly onto workpiece to weld first point on workpiece. After withdrawal, unit moves laterally to a second location and is directly applied to weld a second point. Upon withdrawal, gun swivels back to horizontal rest position.

▶ Control System

The master control panel, lower left of *Fig.* 1, includes two pushbuttons which initiate the automatic operations of the machine, an emergency switch to stop the machine, switches to initiate the welding currents, and jog switches to move transfer carriages between stations when setting up. An illuminated diagram on the panel indicates the location of transfer carriages in the machine at all times. Throughout the machine, limit switches are used to provide electrical interlocks and to signal when various operations are complete. All weld sequences are electronically controlled, and more than fifty 75-kva multisecondary welding transformers are used.

The power supply to each station is controlled by two ignitron controllers arranged to fire one after the other. In most instances, these are required to fire three times in a normal sequence of the welding guns—close, squeeze, weld once, weld again, and hold—which is repeated three times. Several transformers are energized during each single stage sequence. Standard size spot welding electrodes are used, and the electrode tip pressure for each gun is approximately 1400 pounds per square inch.

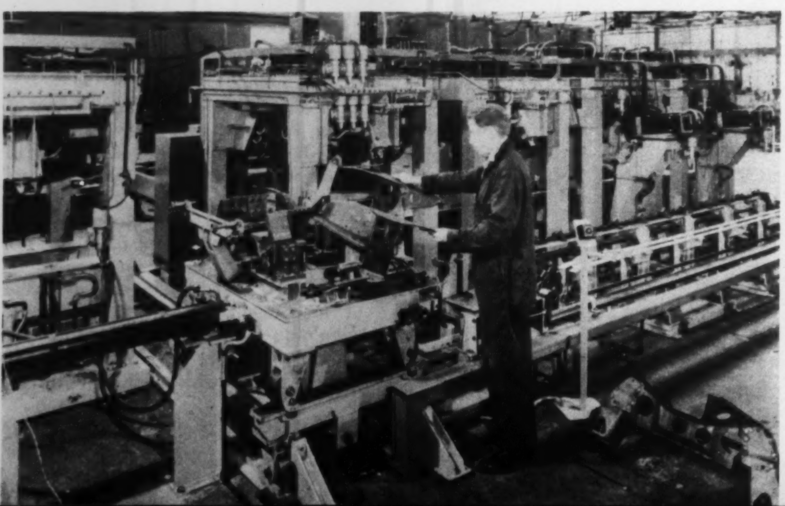
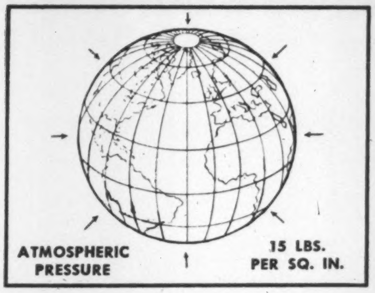
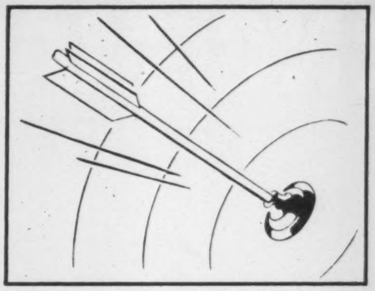


Fig. 4—View shows an operator removing a completed subframe from the transfer carriage fixture at one of the two unloading positions. To operator's right is the chain-type carriage return conveyor which transports carriage back to loading positions. Welded subframe on shop floor shows the complex shape of the assembly and reason for employing six different techniques for positioning welding guns on workpiece.

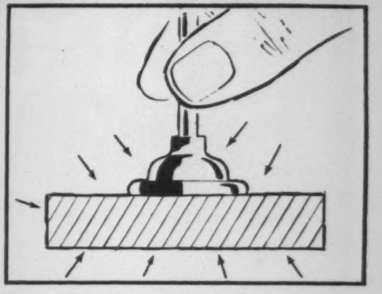
"WHAT IS VACUUM?"



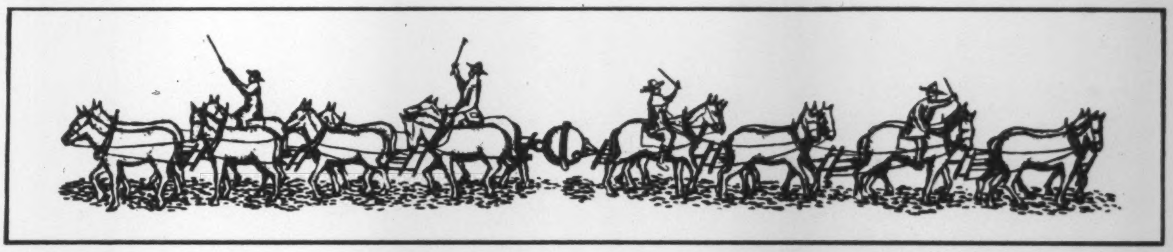
The atmospheric pressure, in which we all exist, has been harnessed to perform a service for you . . . in modern industry. This service is accomplished by removing atmospheric pressure from between two objects, creating a vacuum and bonding the two objects together as one. The literal definition is, "A space entirely devoid of matter."



A simple illustration would be the small rubber vacuum pad attached to children's toys. When this pad is pressed down on a flat surface, the downward movement of the pad forces the air from between the flat surface and the rubber pad, creating a simple vacuum.

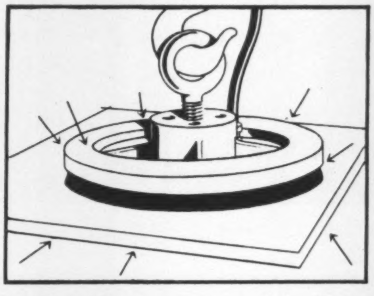


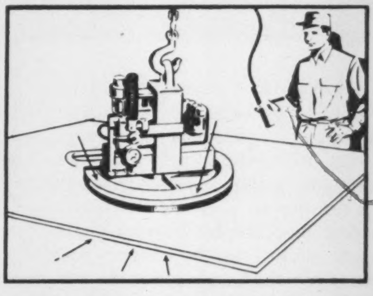
By lifting this small rubber pad, objects can be raised and lowered. This can be accomplished as long as the outside air is not allowed to enter between the two surfaces. The pad is just the means of creating a vacuum, and sealing out the surrounding air.

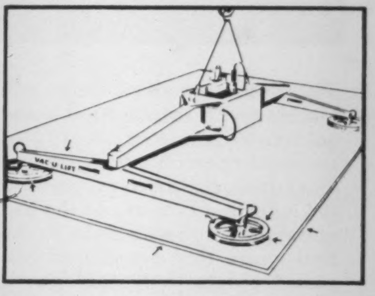


The principle of vacuum is not new. More than 300 years ago, the tremendous power of atmospheric pressure was realized through an experiment by Otto von Guericke in Madgeburg, Germany. Two hollow iron half-spheres, 22 inches in diameter were fitted together and the air inside withdrawn, creating a vacuum. Pressure of the surrounding air held the sphere together so tightly, eight teams of horses failed to pull them apart.

In a much wider and more scientific scale, VAC-U-LIFT systems harness atmospheric pressure and **creates** vacuum for faster, safer, more economical material lifting in modern industry.







A VAC-U-LIFT system consists of: (1) a metal pad, with a flat under surface to do the lifting and a rubber seal ring to seal out the surrounding air; (2) a vacuum pump and motor to create the vacuum; (3) control valves; and (4) a patented reserve vacuum tank.

The VAC-U-LIFT pad and seal ring used in all systems marks a revolutionary departure from all previous efforts to put vacuum to work. The VAC-U-LIFT system eliminates severe lift-capacity problems, leakage, air-evacuation problems, and the time-delay limitations of other vacuum methods. Lifting and holding safety is assured with a patented vacuum reserve system on every unit to keep pressure constant even in the event of power failure. All VAC-U-LIFT's units carry a full 3 months unconditional warranty.

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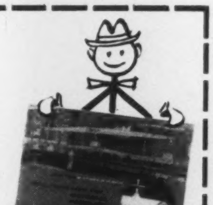

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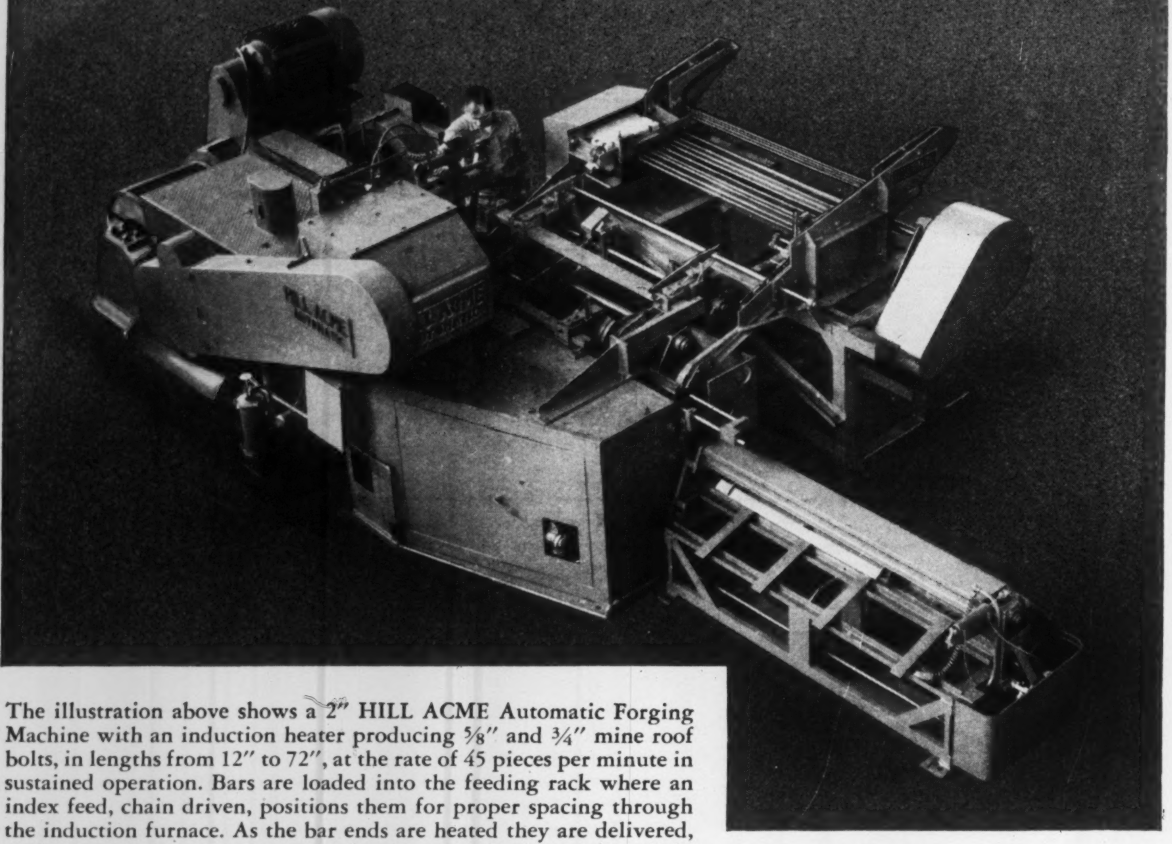

The illustration above shows a 2" HILL ACME Automatic Forging Machine with an induction heater producing ⅝" and ¾" mine roof bolts, in lengths from 12" to 72", at the rate of 45 pieces per minute in sustained operation. Bars are loaded into the feeding rack where an index feed, chain driven, positions them for proper spacing through the induction furnace. As the bar ends are heated they are delivered, at the proper timing cycle, to the forging machine by a roller chain feed where they are gauged for length, picked up by fingers and passed progressively through the dies. Finished forgings are discharged from the back of the machine by means of a separately driven conveyor, arranged for both right and left hand discharge.

The design of this new HILL ACME AUTOMATIC forging unit does not limit the number of passes or the length of stock to be used in forging a variety of parts. Pieces longer than 36" are supported by a walking beam through the various passes.

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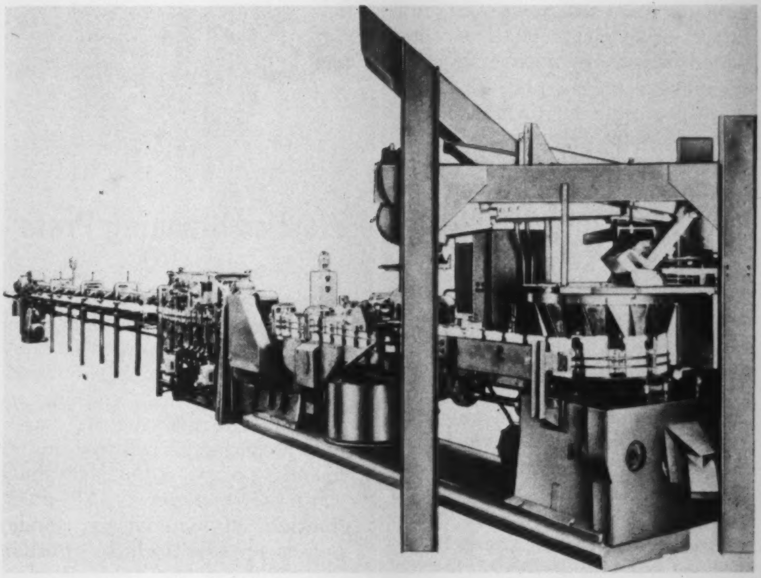
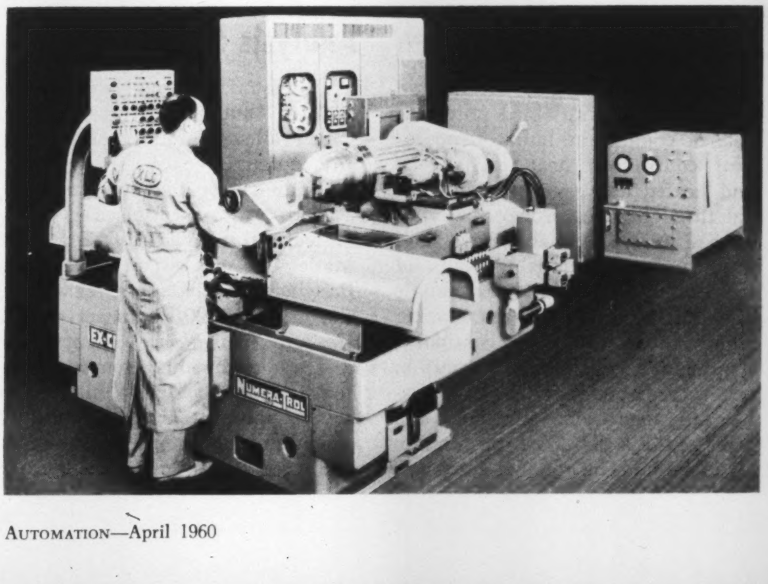


Machine opens, fills, and seals cartons automatically at speeds of 300 per minute.

Carton-Sealing Machine

MACHINE features a carton-sealing process which will produce sealed cartons at speeds up to 300 per minute. The unit, designed by **Packaging Machinery Div., Food Machinery & Chemical Corp.,** 4992 Summerdale Ave., Philadelphia 24, Pa., is suitable for packaging hygroscopic products such as cereals, potato flakes, milk, and dessert powders. In operation, cartons are snapped open, the bottom is sealed, the carton accurately filled, and the top sealed. The sealing strip is then automatically applied and the sealing is completed. The carton-sealing process is designed "Calk-Seal." It is a thermoplastic material applied as a bead along the two top and bottom edges of the carton under the Van Buren ears. When these edge tabs are folded over and sealed, the soft ribbon of Calk-Seal is pressed into the narrow openings. Inner bags and overwraps can be eliminated. The machine can handle end opening cartons of almost every type from one-ounce to three-pound sizes with dimensions from $2\frac{3}{8}$ by $3\frac{5}{8}$ inches up to 8 by 11 inches.

Circle 401 on Page 19



Tape Controlled Contouring Machine

Contouring machine, designed for precision turning, boring, and grinding operations, is capable of being controlled in increments of 25 millionths of an inch, either automatically through a tape controlled process or by a manual control during setup. The unit, designated Numera-Trol 922 is operated under a constant temperature of 72 F. Heat from the electronic equipment contained within the tape reading cabinets is ducted away from the work area and the hydraulic power unit is water cooled. The machine is of building-block construction. The precision turning and boring assembly is self-contained except for the hydraulic power unit. The precision grinding assembly is also a self-contained unit and can be interchanged with the boring and turning unit.

Features of Machine

The machine bed is heavier and more rigid than those in standard machine tools. Slide ways, in addition to being hand scraped for flatness, incorporate precision roller bearings matched to a few millionths of an inch. The cross slide, which weighs approximately 1000 lb, requires only a pressure of $5\frac{1}{2}$ lb to overcome inertia and only 5 lb to maintain movement. The reciprocating grinding head is capable of grinding extremely accurate template contours and complex forms on flat stock. When used in conjunction with a rotary attachment mounted vertically on the cross slide, the grinding of circular cams is possible. The turning and boring head is a precision spindle driven by a variable delivery hydraulic motor. The motor drives the spindle through a direct belt or through a reduction gear unit. When turning the OD or boring the ID of hemispheres, the cutting speed is maintained constant by varying the spindle speed hydraulically to suit the changed conditions. **Ex-Cell-O Corp.,** 1200 Oakman Blvd., Detroit 32, Mich.

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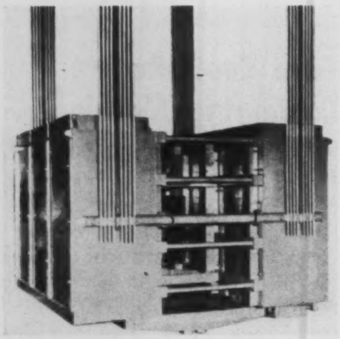

Sifter

Designed for the sifting of dry materials, unit features square, tubular, and horizontal cross members in the structural frame. It is available in four and six section models, with up to eight distinct separations per stack. Other features include ceiling suspension and a level, gyratory action in a perfect circle. **Sprout, Waldron & Co. Inc.,** 130 Logan St., Muncy, Pa.

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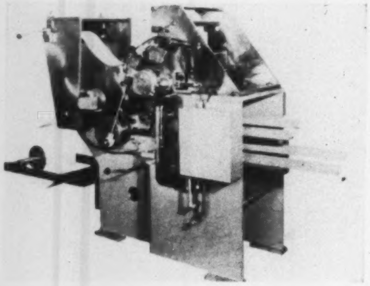

Plastics Blanking Press

Press is capable of blanking thin plastic film at rates of 100-150 strokes per minute. Finished blanks are automatically stacked in chutes by the machine for rapid transfer to the magazines of forming machines. The machine is equipped with a continuous roll feed and automatic scrap cutter. Maximum width of material is 17 inches; thickness of material for standard unit is up to 1/16-inch. **Portland Div., Emhart Mfg. Co.,** Portland, Conn.

Circle 404 on Page 19

Foam Producer

Small-shot production unit is capable of pumping, proportioning, mixing, and dispensing two-component formulations using polyester, polyether, or castor oil bases to produce rigid, semirigid, or flexible foams. The self-contained unit consists of component tanks, temperature controlling heat exchangers, and heated delivery hoses; individual throughput control of materials by positive type variable drives and rotary pumps; and mixing head and foam cycle controls. It can handle materials having viscosities ranging from 1 to 300,000 centipoise. Throughput is variable from zero to two pounds per minute. In operation, the foam cycle is initiated and indicated by the *Start* pushbutton pilot light. The manual-automatic selector switch determines whether the foam cycle is terminated manually by the *Stop* pushbutton or automatically by the cycle duration timer. The timer is set for the required number of seconds, or fractions of a second, to dispense the quantity of foam necessary at the working flow rate of the unit pumping systems. **Martin Sweets Co. Inc.,** 114 S. First St., Louisville 2, Ky.

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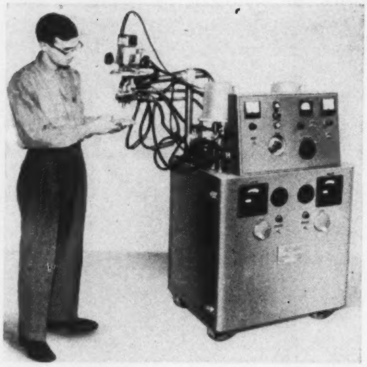
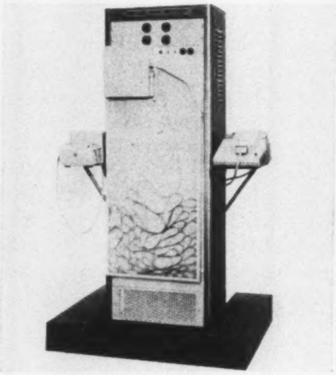
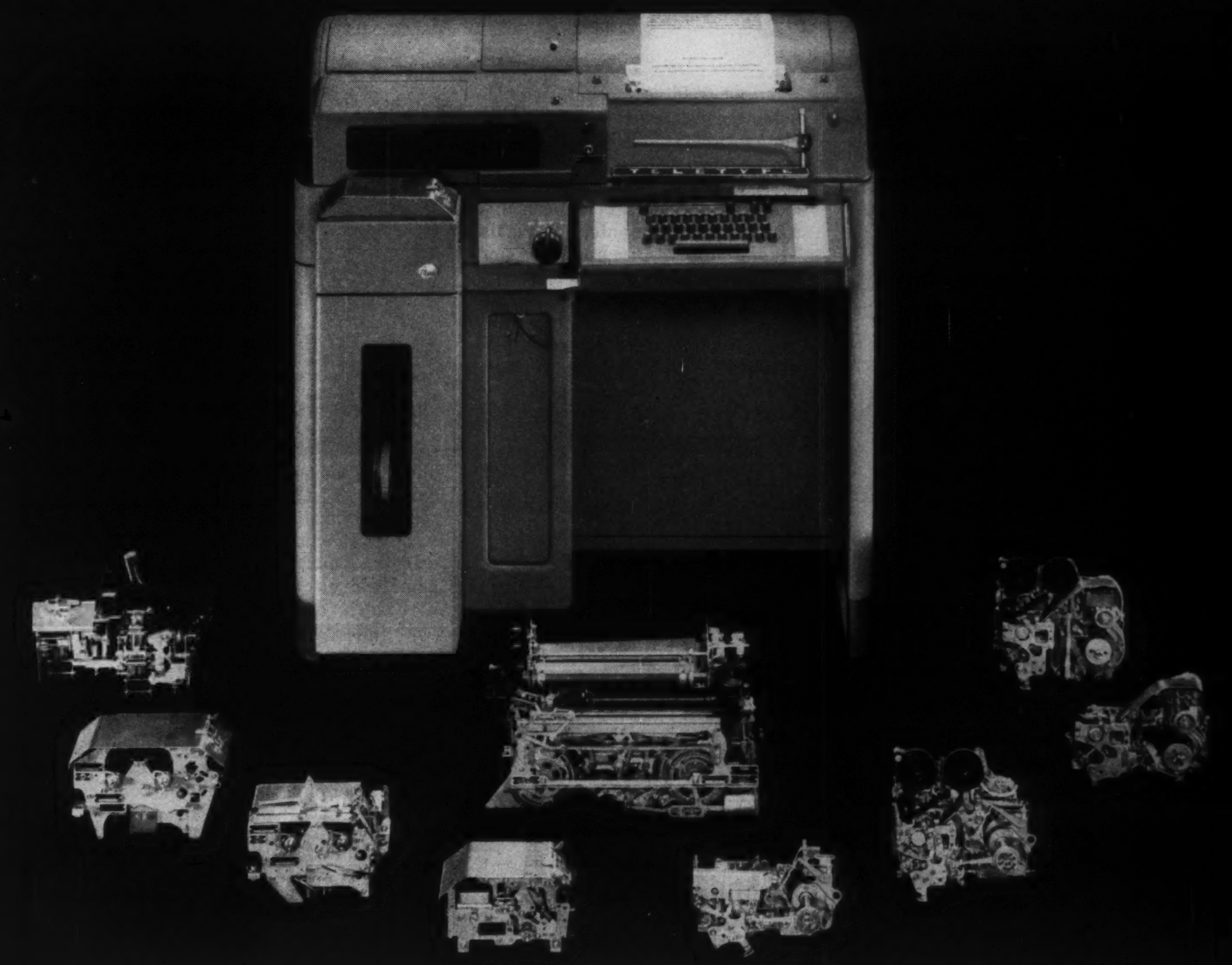




Analysis System

Transistorized analysis system features automatic programming which allows analysis of data in any chosen sequence. In operation, the number of the department or account to be scrutinized is transmitted to a solenoid-activated Digit-Matic and printed on paper tape. Punched tape data are scanned at the rate of 1000 digits per second. Desired figures are accumulated and totaled by the electronic register of the analyzer. While this total is transmitted to the printing unit, the programmer has automatically fed in the number of the next



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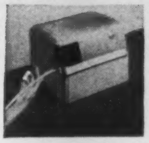
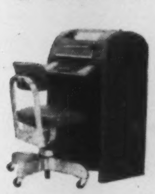
Circle 694 on Page 19



Typing Tape Punch

Tape Reader



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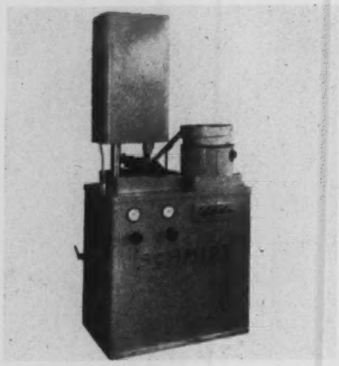
department or account to be analyzed. **Victor Adding Machine Co.,** 3900 N. Rockwell St., Chicago 18, Ill.

Circle 406 on Page 19



Marking Machine

Unit imprints identification marks on hopper fed items such as steel parts or nameplates. Model 10T will stamp character sizes from 1/16 to ¼ inch at production rates from 3000 to 3600 pieces per hour. Uniform marking is obtained on parts which have slight thickness variations without changing the pressure setting. Machine can also be equipped with dial feed for automatic cycling and intermittent movement or with stacker feed. **Geo. T. Schmidt Inc.,** 4100 Ravenswood Ave., Chicago 13, Ill.

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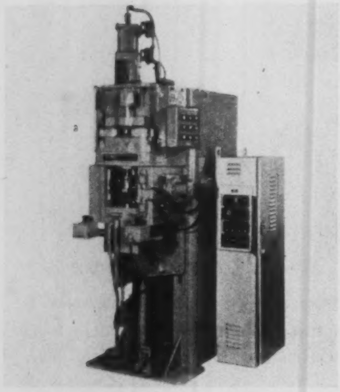
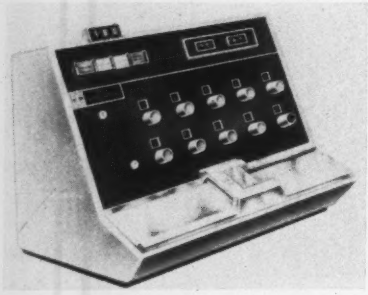


Magnetic Force Welder

Model APPAMFP-1-100-12 is a 100 kva magnetic force projection and spot welding machine with dc holding coil delayed forge and diaphragm safety head. It is designed for welding silver alloy relay contacts in motor starters, but it is adaptable for other operations that require joining of nonferrous metals. The machine is tooled with a sound baffle cage and fume exhaust system for full area percussion welding of large silver-cadmium-oxide contacts to brass contact arms. The electronic welding control is synchronous with selective half cycle and positive and negative heat control functions. **Arco Welder Mfg. Co.,** 1719 W. St. Paul Ave., Milwaukee 3, Wis.

Circle 408 on Page 19



Data Recorder

Self-contained unit collects and records, in computer-intelligible form, all the data needed by computers to process items such as payroll, work-in-process inventory, costs, and scheduling operations. Model 180 automatically assembles variable data (such as job-lot number and amount produced), identification data from prepunched IBM cards (such as employee number and item number), fixed data (such as department and Data Collector number), and time from an internal clock (to the nearest 0.01 hour). The variable data are inserted from 10 manually-operated dials. The identification data are read from IBM cards by a card reader. Output data are recorded at the rate of 15 characters per second on 5, 6, 7, or 8 level punched paper tape. An operator records either at the beginning or end of each operation the desired selectable data. **Control Data Corp.,** 501 Park Ave., Minneapolis 15, Minn.

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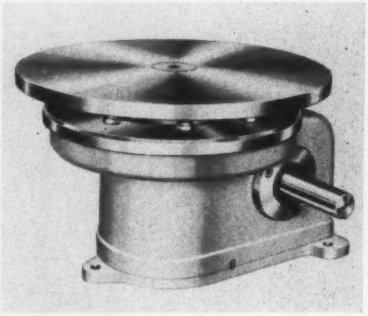
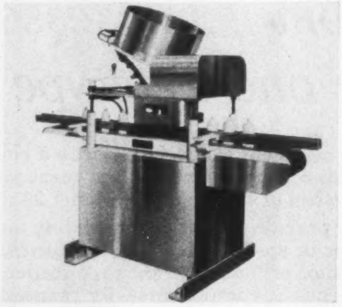


Indexing Turret

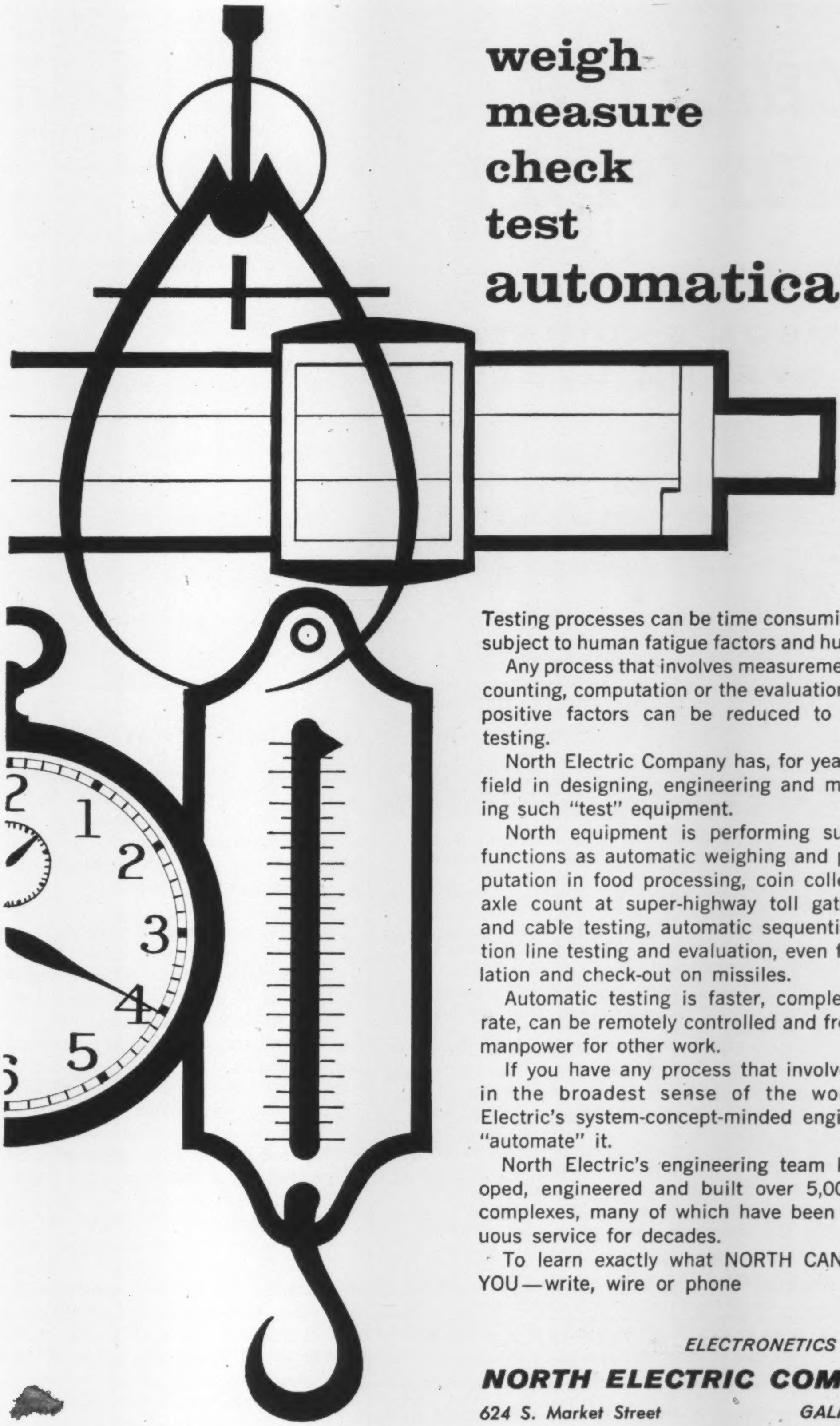
Miniature turret indexing unit is built for semiautomatic bench operations, or it can be used as a small automatic machine chassis. Another function is that it can be used as an auxiliary turret on larger automatic machines. Model J has a 12-inch diameter turret, eight work stations, and an index to dwell relationship of 1:1. The unit incorporates a drive motor, reduction unit, and main camshaft extension for mounting tool actuating cams. Power is provided by a ¼ hp, 60 cycle, 220 v electric motor. Two table mounting arrangements are available. The foot type mounting (shown) is used when auxiliary tool mounting surfaces are to be provided; and the flange type mounting is used when the unit is recessed below the table top. **Swanson-Erie Corp.,** 816 E. Eighth Ave., Erie, Pa.

Circle 410 on Page 19



Plug Inserter

Automatic, straight line machine inserts restriction plugs in nonpressurized soft plastic spray containers with neck widths of from 8 mm to 24 mm. It can make insertions at speeds up to 120 per minute and higher, depending on the container size. In a production line, the in-



weigh
measure
check
test
automatically

Testing processes can be time consuming and are subject to human fatigue factors and human error.

Any process that involves measurement, weight, counting, computation or the evaluation of known positive factors can be reduced to automatic testing.

North Electric Company has, for years, led the field in designing, engineering and manufacturing such "test" equipment.

North equipment is performing such varied functions as automatic weighing and price computation in food processing, coin collection and axle count at super-highway toll gates, circuit and cable testing, automatic sequential production line testing and evaluation, even fault simulation and check-out on missiles.

Automatic testing is faster, completely accurate, can be remotely controlled and frees skilled manpower for other work.

If you have any process that involves testing, in the broadest sense of the word, North Electric's system-concept-minded engineers can "automate" it.

North Electric's engineering team has developed, engineered and built over 5,000 system complexes, many of which have been in continuous service for decades.

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NORTH ELECTRIC COMPANY
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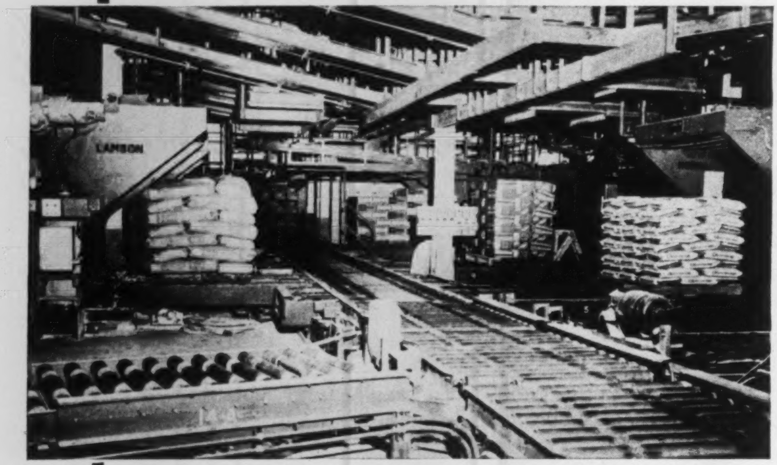
60-S-2

Circle 695 on Page 19

MECHANIZE... PROFIT-WISE!

WITH
LAMSON ENGINEERED
CONVEYOR SYSTEMS



Automatic Palletization — the hub of a LAMSON engineered conveyor system linking production lines to warehouse.

You cut production time and the unnecessary handling of materials to the bone with the help of LAMSON engineers. They are specialists in developing materials handling systems that truly increase the capacity of your present buildings and dramatically increase the productivity of your present equipment.

There are more LAMSON custom engineered conveyor systems in successful operation today than any other kind. They are being serviced throughout their life by the same LAMSON field offices that initially analyzed the problem, proposed the solution and supervised the installation.

As a result of this complete, professional service you will find many of the finest names in industry among LAMSON installations. During the past 75 years LAMSON has been active in almost every field, yours included, and perhaps even in divisions of your own firm. LAMSON can cut costs; speed production; increase your profits.

If you have a materials handling problem, write LAMSON today for our conveyor catalog and the name of your nearest LAMSON Field Engineer. Or, simply clip this advertisement to your letterhead and mail to:

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LAMSON CORPORATION
408 Lamson Street, Syracuse 1, New York

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Circle 696 on Page 19

sertion machine is stationed after the filling unit and before the capper. Model PB operates on a continuous motion principle with no halt in flow during plug insertion. Containers are neck-gripped to prevent collapse of the soft plastic body during insertion. Plugs are hopper fed, positioned, and inserted automatically. **Resina Automatic Machinery Co. Inc.,** 572 Smith St., Brooklyn 31, N. Y.

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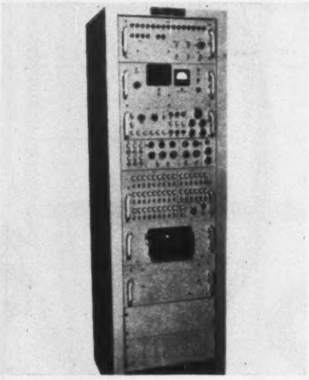
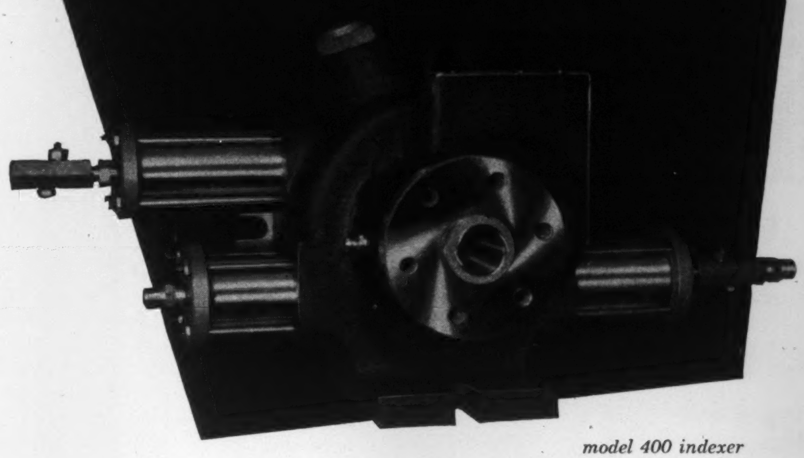


Numerical Press Control

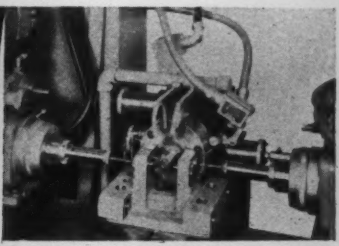
Integrated programmed control of a high-speed punch press is the function of numerical control system. Operating from a punched paper tape, the system directs the positioning of the stock in the press, opens and closes the stock clamps, and actuates the appropriate punches and cut-off dies. It features closed-loop, interlocked digital control of all press functions. After the stock is loaded and the cycle started, the operation is completely automatic.

The press punches holes of various sizes and shapes in linear bar stock and cuts finished pieces to the desired length from information received on a punched paper tape. Information entered on the tape tells the system the size of the desired piece and the number, types, and locations of holes. Through internal logic, the system determines the sequence of operations. A hydraulic positioning system on the press advances the stock. Feed rates of up to 80 ips are accommodated. Production quantities can be controlled independently of the tape program by setting up the de-

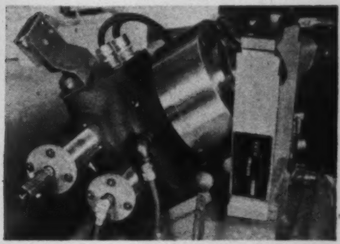
For speeding precision production
AUTOMATE
with
Erickson Indexers



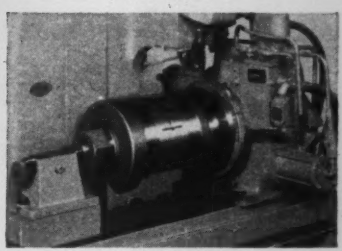
model 400 indexer



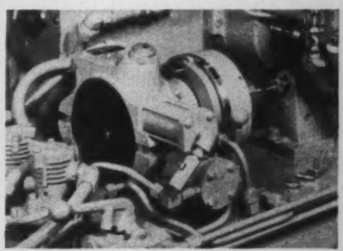
Automatic drilling of cross holes being done on Erickson Model 400 Speed Indexer with air cylinder and Expanding Drawbar Mandrel. Indexer equipped with interlock limit switches.



Angular drilling in jet part held in air operated collet chuck on Erickson indexer operating automatically. Entire fixture designed and built by Erickson.



Using end-clamping for half bearing, machine mills 8 oil grooves then skip indexes back to starting position for next part.



Milling four and six flats on needle valve part. Owing to size, part is placed in tail stock head-first, and tail stock then positions it in chuck and retracts.

Perhaps these actual applications of automation will trigger your imagination . . . show you how Erickson Indexers can help you smash bottlenecks in your own production operation.

You can interlock them into production setups with microswitches and solenoid valves. And with Erickson Indexers you automatically get consistent positive positioning within 2 minutes of a degree . . . repetitive accuracy in low "tenths" of a thousandth.

Speed to keep lines humming . . . accuracy to banish rejects . . . long life to slash maintenance and capital investment—all add up to Erickson Indexers.

A-1562A

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COLLET CHUCKS • EXPANDING MANDRELS • AIR-OPERATED CHUCKS • FLOATING HOLDERS • TAP CHUCKS
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• EXPANDING JAW MANDRELS • SPECIAL HOLDING FIXTURES (including gear-holding)
• BORING BARS • SPADE DRILLS • RECESSING TOOLS

Circle 697 on Page 19

NEWS ABOUT SCALES

How did this team solve an age-old weighing problem?

Since 5,000 B.C. men have been trying to devise a pivot balance that would be highly sensitive yet remain accurate. The breakthrough came in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had invented a revolutionary new scale.

Knife-edged pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem. Thayer guarantees this leverage system accurate for the life of the scale.

How Can It Save You Money Year After Year?

Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.

THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. THAYER PARK, PEMBROKE, MASS.

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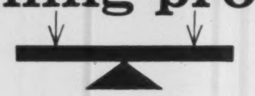

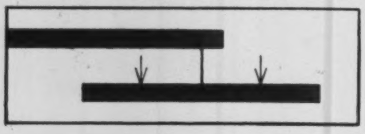

sired number of pieces per bar and pieces per run on controls located on the main cabinet. Numerical indicators display the pieces remaining in the bar and the run. The operating sequence is stopped when the selected number of pieces has been made. **Auerbach Electronics Corp.**, 109 N. Essex Ave., Narberth, Pa.

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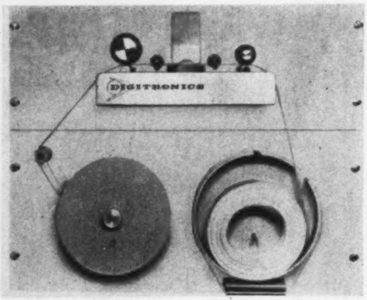

Tape Spooler

Spooler unit, designed for use with perforated tape reader, can handle 300 feet of punched paper or Mylar tape. Model 4533 has a 6-inch diameter take-up reel and a feed bin. The unit can be used with company photoelectric readers for operating speeds up to 300 characters per second. It mounts on a standard 19-inch relay rack directly beneath the reader; requires only 8¾-inch of panel space. **Dykor Tape Reader Div., Digitronics Corp.**, Albertson, L. I., N. Y.

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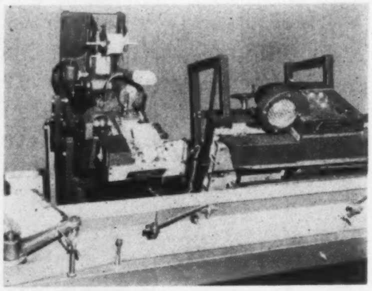
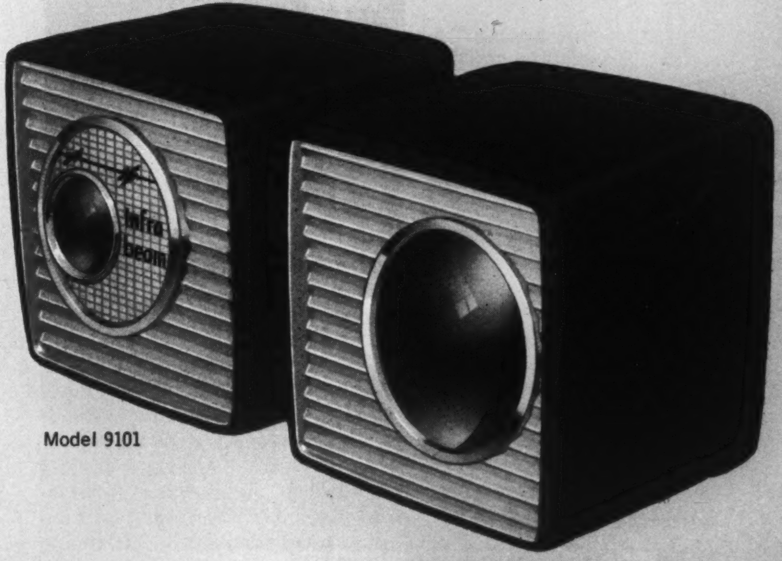


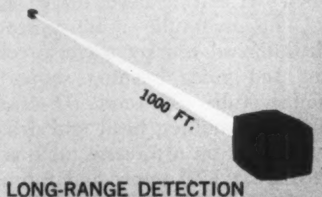
Label Applicator

Designed to apply labels to polyethylene bagged products, unit can be installed as part of a packaging production line. Model 300 can affix perforated edge type labels or

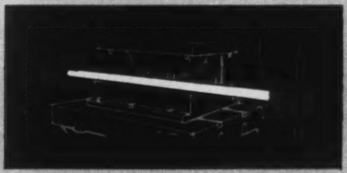
Announcing
Infrabeam
... the revolutionary photoelectric control using modulated infrared radiation



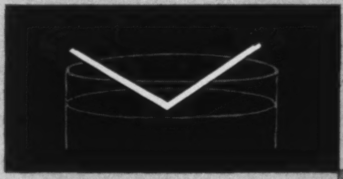
Model 9101



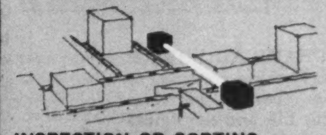
LONG-RANGE DETECTION



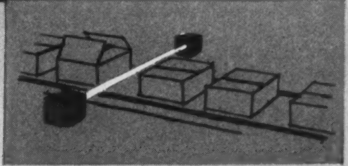
MACHINE CONTROL



LIQUID LEVEL CONTROL



INSPECTION OR SORTING



CONVEYOR CONTROL

FOR THE FIRST TIME, photoelectric control is *simple, reliable,* and *practical* over an extremely wide range of applications.

Infrabeam is a totally new type of photoelectric control . . . developed and tested over a period of more than a year, now ready to go to work in your plant or as part of equipment you manufacture. It offers a combination of simplicity, sensitiveness and reliability that has never before been achieved.

New infrared detectors, perfected for missile guidance, are in many ways superior to photocells that respond to visible or ultraviolet light. In Infrabeam, the Receiver contains a similar infrared detector which is screened against visible light by a simple optical filter. Further, the infrared beam from the Projector is "modulated" — brightening and dimming at a frequency of 400 cycles per second. The Receiver is electronically tuned to this frequency, so that the control will not respond unless it gets a signal from the associated Projector.

WHAT THIS MEANS TO YOU . . .

Compared with standard "general purpose" photoelectric controls, Infrabeam provides far greater sensitiveness in countless applications at close or moderate range. At extreme range — as much as 1000 feet — it offers superior reliability and freedom from interference. Because it operates equally well by reflecting the infrared beam from a detected object and into the Receiver, it is the *only* photoelectric control able to reach into "blind" areas with perfect freedom of installation.

Projector and Receiver are attractively housed in anodized cast aluminum. The quick-detach hinge allows easy separation for use as opposed units, or accurate angling for use in reflection. Physical mounting and electrical connections are simplicity itself, and permit quick replacement of either unit without disturbing permanent wiring.

Find out how simple and practical photoelectric control can be for *you.* WRITE TODAY FOR COMPLETE DETAILS AND SPECIFICATIONS.

ELECTRONICS DIVISION
CRAMER CONTROLS
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Circle 699 on Page 19

solve your control problems with

SENECA FALLS control systems and components

Complete systems available from fractional to integral horsepower for control of:

speed... position... instruments... manufacturing processes... single and two dimensional tracers ...synchronized drives, etc.

In addition to complete systems we can supply:

sensing devices... control components... tape controls... power drives... any tables, carriages or other movable structures required.

Seneca Falls Systems are equally suitable for the conversion of existing equipment and the control of new equipment.

INVESTIGATE the unique Seneca Falls MECHANICAL POWER AMPLIFIER. It's a simple, power servo drive in striking contrast to the more complex electrical and hydraulic devices. Years of service in rugged applications prove its dependability, long life and negligible maintenance. Its excellent dynamic response permits the design of high sensitivity control systems.

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PIONEERS IN AUTOMATION

Write Dept. A for Bulletin EE1008 and, if possible, tell us all you can about your control problem.

SENECA FALLS, MACHINE CO.
ELECTRONICS DIV. • SENECA FALLS, N. Y.

Circle 700 on Page 19

pressure sensitized tags to baked goods, paper goods, soft goods, and housewares. The unit is activated by an electric eye, assures positive application of a single label per package for as many as 144 packages per minute. It can handle labels ranging in size from 1/2 to 1 7/8 inches in height and 1 to 4 inches in width. **Amsco Packaging Machinery Inc.**, 31-31 48th Ave., Long Island City 1, N. Y.

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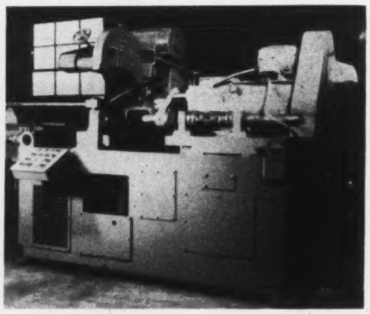

Tube Cutoff Machine

Unit clamps single and double tube ends, cuts them off to length, and chamfers the OD and ID. The machine can handle tube sizes ranging from 1 1/2 to 4 1/2 inches in diameter. A 10-hp abrasive cutoff saw with 18-inch diameter wheel is mounted on the machine. Clamping is secured by a two post cam lock clamp driven by a torque wrench. A cutting head, driven by a 7 1/2-hp hydraulic milling head with outboard bracket traverse columns and guide bushing support, chamfers tube OD and ID after cutoff. The milling head and drive are mounted on a traverse table actuated by a lead screw and torque wrench so that double tube sections can be machined without reclamping. The machine is also provided with a tube handling system for tubes up to 40 feet in length. Included is a supply rack with escapement arms to eject one tube at a time to a feed stand with adjustable hourglass rolls. A disappearing flag stop is adjustable for cutting tubing to accurate length. After cutting and machining, the tube is sent to a storage rack. **Automation Development Corp.**, 135 Reynolds Rd., Mentor, Ohio.

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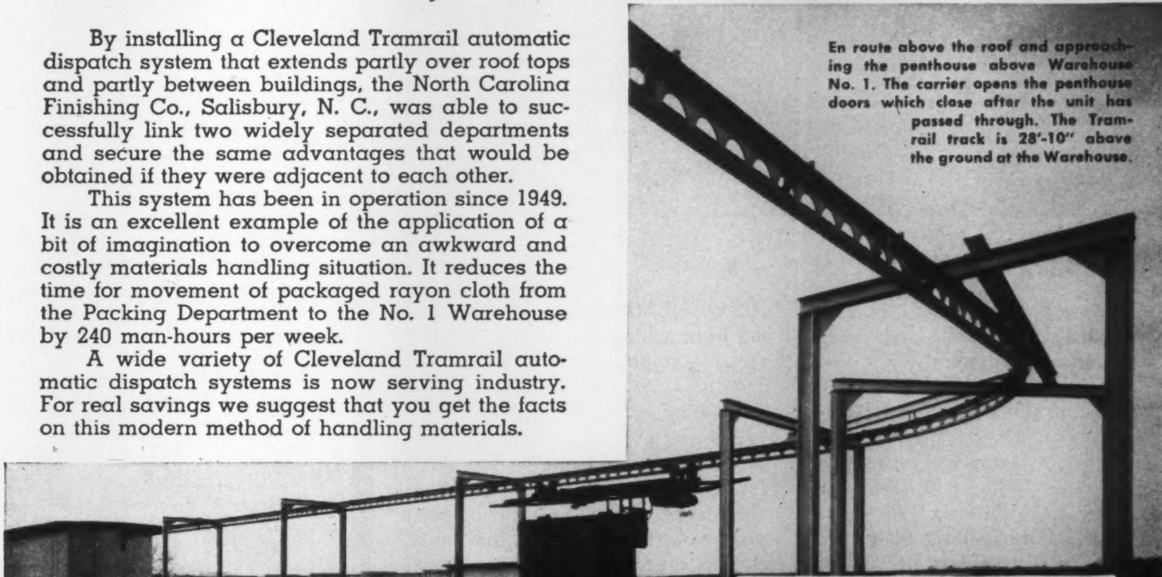
Uses Roof To Link Distant Departments

Automatic Tramrail System Saves "240 Man-Hours" Per Week

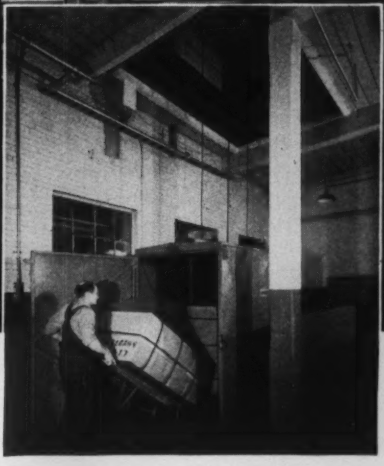
By installing a Cleveland Tramrail automatic dispatch system that extends partly over roof tops and partly between buildings, the North Carolina Finishing Co., Salisbury, N. C., was able to successfully link two widely separated departments and secure the same advantages that would be obtained if they were adjacent to each other.

This system has been in operation since 1949. It is an excellent example of the application of a bit of imagination to overcome an awkward and costly materials handling situation. It reduces the time for movement of packaged rayon cloth from the Packing Department to the No. 1 Warehouse by 240 man-hours per week.

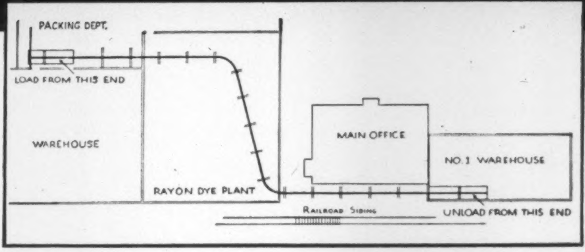
A wide variety of Cleveland Tramrail automatic dispatch systems is now serving industry. For real savings we suggest that you get the facts on this modern method of handling materials.



En route above the roof and approaching the penthouse above Warehouse No. 1. The carrier opens the penthouse doors which close after the unit has passed through. The Tramrail track is 28'-10" above the ground at the Warehouse.



6 to 8 cartons weighing 100 to 400 lbs. each are loaded into the Tramrail freight van. The button on wall, at left, sends the van on its way, first upward through ceiling opening, and then forward on outside roof track. The van measures 4'-0" x 8'-0" x 6'-6" high.



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DISPATCH
SYSTEMS

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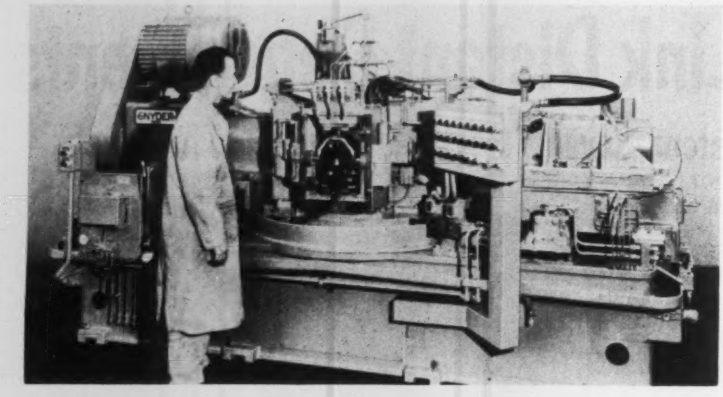
Gives data on a variety of cost-reducing
automatic handling installations.

CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
1305 East 290th Street, Wickliffe, Ohio

CLEVELAND TRAMRAIL

OVERHEAD MATERIALS HANDLING EQUIPMENT

Circle 701 on Page 19

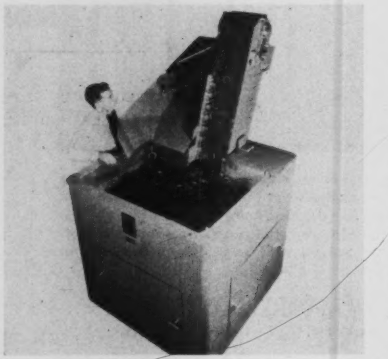


Dial Index Machine

Three-way dial index machine mills, drills, chamfers, and reams malleable iron automotive differential carriers at a rate of 85 pieces per hour at 100 per cent efficiency. Cross-feed heads are used in all work stations to carry out face milling at one station; drilling and reaming operations at the second station; and the milling of pedestal pads in two positions at another station.

The differential carriers are loaded into a fixture on the index table in the first station and clamped by an air cylinder mechanism. The fixture includes air actuated wedge-type jacks that support the part securely for the subsequent heavy machining operations. At the second station, the face of the carrier is milled by cross-feeding a large-diameter face milling cutter. In the third station, a pair of locating holes is drilled and chamfered in one position. The head then cross-feeds to the second position and reams the holes. At the fourth station, a pedestal pad is end milled in one position and then the head is cross-fed to permit the milling of the other pad. An index table carries the parts through the machining sequence. **Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich.

Circle 416 on Page 19



Elevating Feeder

Parts manufactured from metal, plastic, felt, or rubber materials, in practically any shape, are automatically fed and oriented in a continuous flow to processing or assembly machinery by new unit. The elevating feeder is available in three sizes: 6, 12, and 20 cubic foot holding capacities. The feeder is driven by either a fixed or variable speed drive, which includes speed reducers, self-aligning ball bearing pillow blocks, and precision-steel roller chain and sprockets. Automatic controls are available for use in demand feeding. A safety slip clutch prevents damage to drive and elevator. The elevating mechanism consists of a double-strand, precision-steel roller chain with elevating flights arranged for right or left-hand discharge. Orientation of parts is accomplished at discharge point of elevator. When handling parts that have a tendency to jam or bridge, the feeder can be equipped with a hopper agitator. **Detroit Power Screwdriver Co.**, 2801 W. Fort St., Detroit 16, Mich.

Circle 417 on Page 19

®
PACIFIC

ARE YOU DECIDING WHAT ROUTE TO GO IN PLANNING AN AUTOMATED FACILITY?

Most automated plants, be they military or industrial, involve extensive use of electronic equipment. In "Operation Turn-key," PAP provides the optimum combination of A-E skills, advanced electronic engineering and manufacturing. The result—*superior performance at low cost*... a managed project—anywhere in the world.

Here are the departments of PAP which comprise "Operation Turn-key:"

■ ARCHITECT-ENGINEER SERVICES

The A-E staff is made up of architects, engineers, designers—specialists in structures, materials handling, processes---Their tasks may include feasibility studies, economic analyses, site selection, master planning, preliminary and final design, specification and procurement of equipment and services, construction supervision, project management.

■ ELECTRONIC SYSTEMS ENGINEERING

This is a group of top electronics men—many with advanced degrees—all with solid experience in diverse fields. Their contribution to the automated facility is to design the complete electronics system, specify equipment, and engineer the installation.

■ SPECIAL ELECTRONIC PRODUCTS

True automation often involves special equipment that is unique to your requirements. PAP, and its subsidiary, Space Electronics Corporation, offer top capability in design and manufacture of electronic products from black boxes to the most sophisticated systems.

■ CUSTOM CABLE COMPONENTS

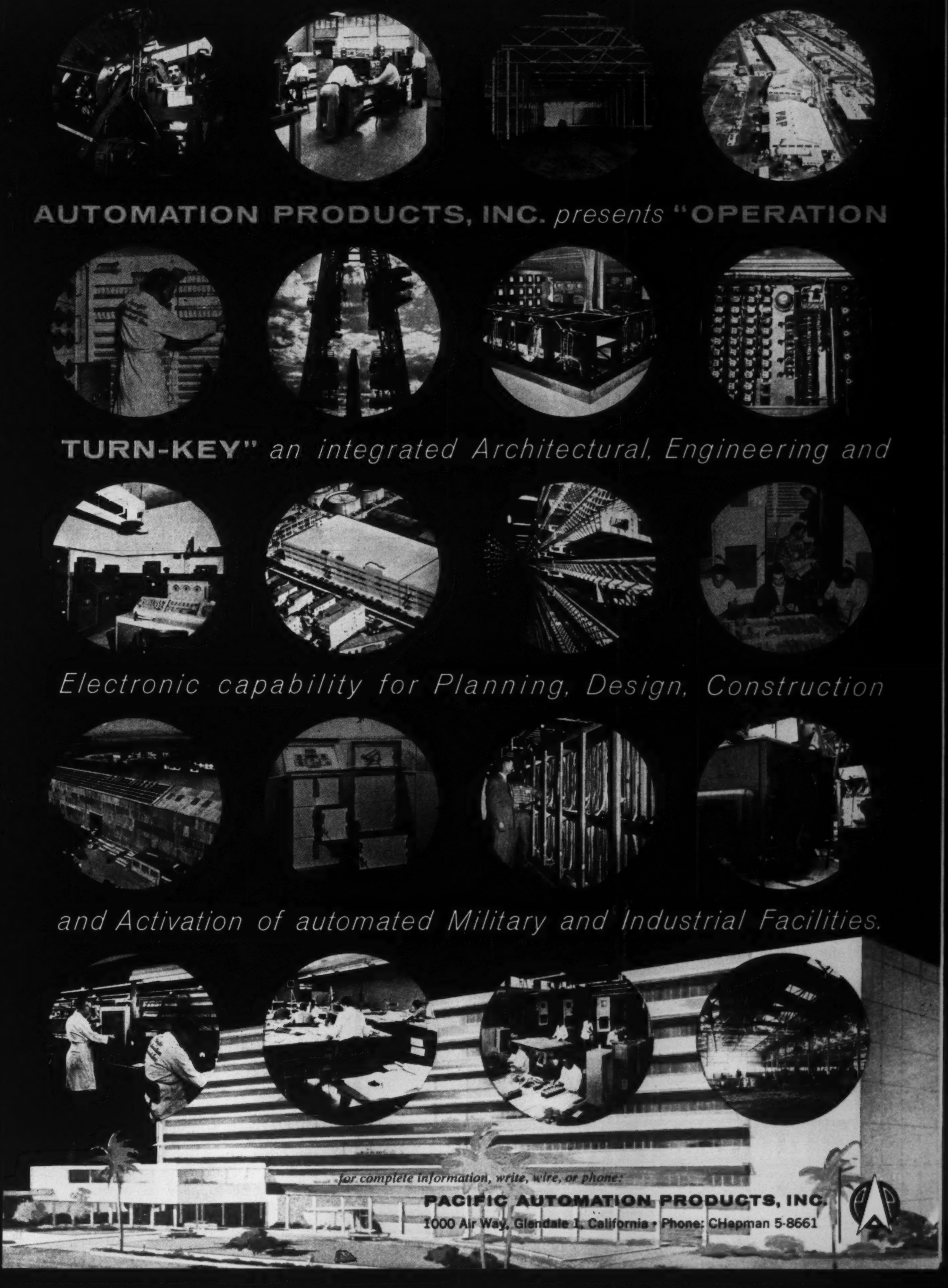
Cables are the *lifeline* of an electronic complex. PAP designs and manufactures cable assemblies for all environments. Its reputation for reliability has made Pacific Automation the most respected name in the cable systems industry.

■ FIELD INSTALLATION

This technically competent and immensely practical group of people installs all electronic and mechanical equipment, checks it out, and turns over to you complete drawings, instructions... *and* THE KEY TO THE FRONT DOOR.

ENGINEERS: *Make your future with this dynamic growing company. Send your resume today.*

Circle 702 on Page 19



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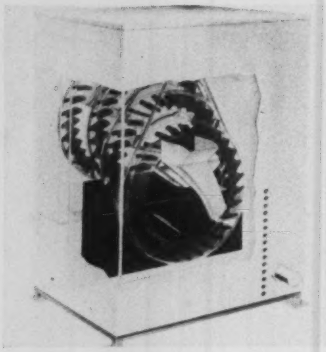
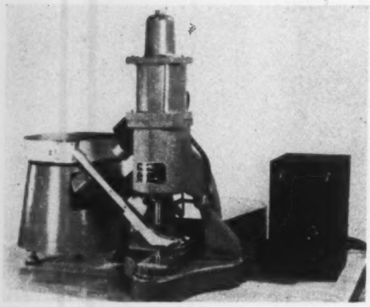


Cleaner/Degreaser

Unit is adaptable for cleaning and degreasing metal parts of all shapes, including cups, sharp points, and balls. It can be used with acids and with water detergents. The cold solvent process with ultrasonics removes all oils, drawing lubricants, smut, chips, polishing abrasives, and dust. Process can leave a moderate rust-proofing if desired. In operation, parts enter the unit, designated Auto Sovex, directly from automatic grinders, screw machines, blanking presses, and other metal parts fabricating devices, or from tote boxes via the vibratory hopper feed. A series of four rotating wheels with evenly spaced cubicles hold the metal parts. As the parts automatically move through the series of wheels, they are immersed in a degreasing solution, powered by ultrasonics, rinsed, drained, and finally passed through an isolated solvent drying chamber before being discharged. **Metalclean Equipment Co.**, P. O. Box 177, Bala Cynwyd, Pa.

Circle 418 on Page 19



Terminal Setter

Model FST-1 Electroset can orient, feed, and set split lugs, feed-throughs, and single end terminals at the rate of 100 terminals per minute. Machine consists of an Electropunch, vibratory feeder, orienting devices, trackage, electrical controls, and power feed. In operation, terminals are fed from the vibratory feeder to a track. The terminals pass down the track, past a photoelectric cell to an escapement. When the track is approximately 2/3 full, the photoelectric cell shuts off the vibratory feeder. From the escapement, the terminals pass into a second track and are fed under power to the staking nest. The nest consists of spring-loaded jaws controlled by the feed motor. The jaws grip the terminal firmly during the staking operation and then release it for ejection. The feeding mechanism is capable of presenting terminals in the staking nest at the rate of 100 per minute. Once in the nest, an operator places the board over the terminal and actuates the unit with a foot switch to stake the terminal in the board. **Black & Webster Inc.**, 570 Pleasant St., Watertown 72, Mass.

Circle 419 on Page 19

Electronic Sorter

Hopper fed electronic sorter can orient and segregate items such as drill blanks and turned machine parts. An electronic sensing device registers in its memory system the orientation of the part and diverts it into the proper track. For example, it can sort drill blanks into two groups so that in one group the points are all leading and in the other group the points are all trailing. An alternate arrangement can also be supplied in which all

POST DECITRON ELECTRONIC PRODUCTS

MODEL K-5 — Multi-Purpose Electronic Control counts up to 1000 units per minute

POST'S K-5 control features a hermetically sealed solid state photocell which lasts indefinitely. Relay is a single pull, double throw type, DC operated for maximum reliability. No vacuum tubes to short circuit or burn out . . . little service required. Rugged enclosures are provided for both light source and receiver and input voltage may be supplied from any 115 V outlet.

The K-5 may be used as an on-off control, go-no go control, or for many other applications including safety devices, liquid level or illumination control limit switch or jam detection sensing.

Write for bulletin K-5.

Decitron

ELECTRONIC PRODUCTS DIVISION

Post Machinery Co. | 159 Elliott St., Beverly, Mass.

Circle 703 on Page 19

Reliance Super 'T' V★S Drives

Automatic process control from standard off-the-shelf components

Complex control systems are easily designed using the Reliance V★S Building Block Approach. Off-the-shelf components can be combined in wide variety to perform a diversity of precise control functions. The control of speed, torque and horsepower . . . the synchronization of motor speeds through feedback systems . . . and the accurate sensing devices that make precise control possible are an integral part of the V★S system.

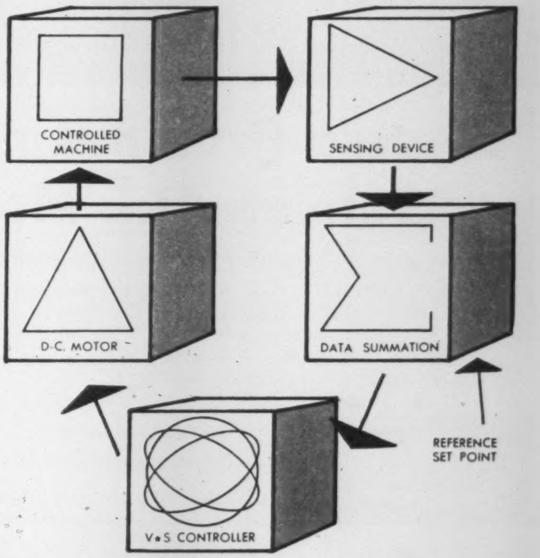
Pneumatic, hydraulic and electric sensing equipment—such as pressure gauges, photo electric cells, level indicators, or strain gauges can be tied directly to V★S Drives. Many single-point and point-to-point numerical and digital systems have also been designed around these V★S Drives.

Fast—Stepless—Wide Speed Range

V★S Drive components consist of a d-c. drive motor, packaged motor controls and operator's control station. Operation is from in-plant a-c. circuits. You need only the drive motor at the machine . . . controls can be placed at any convenient location.

High response Reliance drive motors change speed over a wide range, smoothly and without steps. Selections are infinite. All-electric V★S design permits inclusion of dynamic or regenerative braking for fast stopping.

A motor-generator set forms the nucleus of the motor control unit. Built-in controls regulate voltage and current in the system. You can get any required combination of speed, horsepower, torque and time characteristics.



Typical V★S System Using Building Block Approach

And New Super 'T' V★S Drive Now Gives You More Power in 35% Less Space!

Through use of Class B insulation—better ventilation and new NEMA re-designed a-c. and d-c. machines, more power is packed into sharply reduced space. *And this V★S Drive will take 100% overloads for one minute duration without failure.*

Reliance Super 'T' V★S Drives can be custom designed to meet your specific needs.

Reliance Sales Engineers are always available to work with you. Call your nearest Reliance sales office or write for Bulletin D-2506.

D-1642

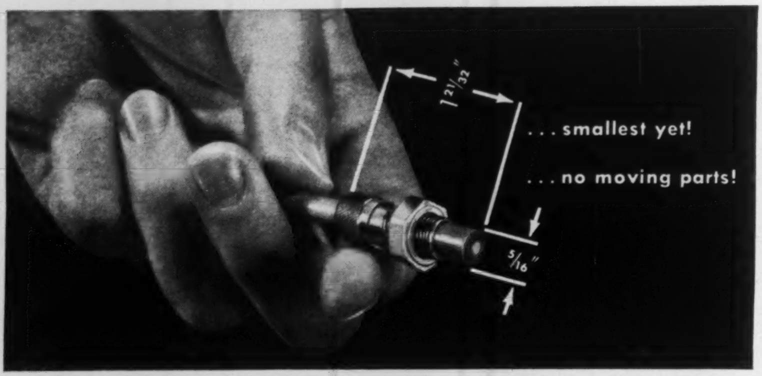
Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 264A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities

Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

Circle 704 on Page 19



Electro Proximity Switch Senses ALL Metals

Solves metal control problems where mechanical switches fail . . .

RELIABLE . . . unaffected by nearby 60 cycle AC fields.
LOW COST . . . replacement probes from $18.50.
CONVENIENT MOUNTING . . . 3/8"-24 threaded hole.
FAST . . . 60,000 operations/minute.
RUGGED . . . oil and waterproof.

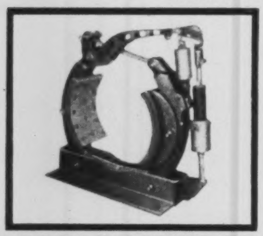
Electro
ELECTRONIC EQUIPMENT

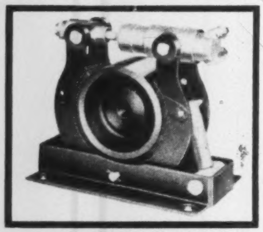
Write for Detailed Bulletin PP-29!
ELECTRO PRODUCTS LABORATORIES 4501-A Ravenswood, Chicago 40
Canada: Atlas Instrument Corp., Ltd., Toronto, Ontario
0150

Circle 705 on Page 19

STOP EQUIPMENT SAFELY

with Wagner





AIR POWERED or HYDRAULIC BRAKE SYSTEMS

Wagner makes both air powered and hydraulic industrial braking systems that stop your equipment safely, easily, economically.

WAGNER AIR POWERED BRAKING SYSTEMS use the same heavy-duty brakes that Wagner builds for hydraulically operated overhead crane brakes. Application is flexible . . . any number of brakes and control points may be used at reasonable distances from each other.

WAGNER HYDRAULIC BRAKE SYSTEMS let you put the *right* braking system on your large or small cranes. Example: new 6" x 3" size brakes are perfect for floor-operated or small cab-operated cranes.

Let your nearby Wagner Sales Engineer help you select the braking system best suited to your needs. Call him today.

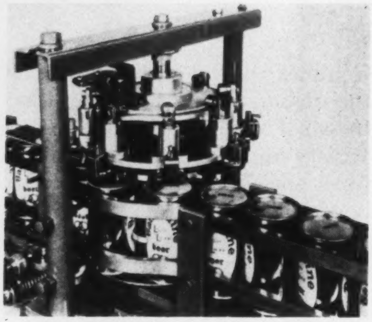
W160-4

Wagner Electric Corporation
6430 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

Circle 706 on Page 19

the oriented parts are discharged down a chute with the same end always leading. Changeover time from one size or shape to another is less than ten minutes. **U. S. Engineering Co.**, 40-28 22nd St., Long Island City 1, N. Y.

Circle 420 on Page 19



High-Speed Imprinter

Device imprints code-dates or other short legends on the top of cylindrical products such as cans, jars, and bottles. Model TMT is self-powered and self-synchronizing; will operate at any rate up to 1000 units per minute. It accelerates and decelerates automatically to match product flow. The ink supply will last for a whole day's operation. Machine is adjustable for different product sizes, and can print surfaces recessed as much as 5/8-inch. **Adolph Gottscho Inc.**, Hillside 5, N. J.

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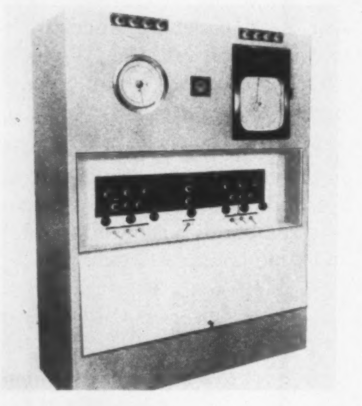
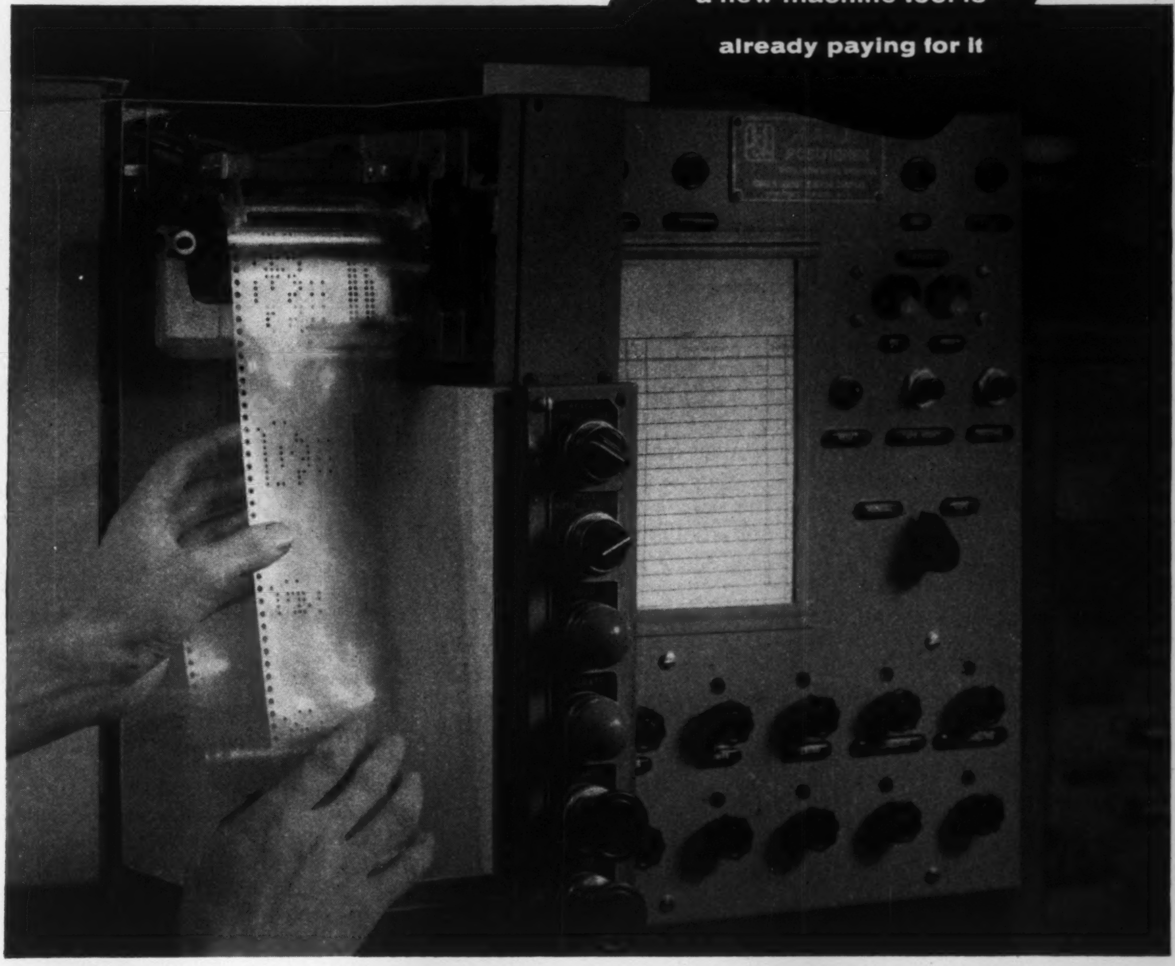


Batch-Weigher

Bulk - materials batch - weighing system can be used to batch-weigh two, three, four, or more ingredients, in programmed sequence, in

JONES & LAMSON "AUTOMATION"

the man who needs
a new machine tool is
already paying for it



Numerical Control . . . what's it worth?

What *about* numerical control: is it all it's cracked up to be? The answer, in a word, is "yes". Here's why. With numerical control, the *big* factor is *flexibility*. Tape or numerical programming can be employed economically for medium or small lot production, even down to *single pieces*. Accuracy is also increased. For instance, Jones and Lamson tape controlled positioning units hold tolerances of ±.001 on applications for punching, drilling, boring or similar operations where point-to-point positioning is mandatory. Machine set-up and change-over become primarily an office procedure. Numerical control of machining operations eliminates the need for cams, templates, even prototype parts and special fixtures. It results in greater machine utilization, and speeds actual machining. Lead time is reduced, and because human error is largely eliminated, accuracy is improved.

Any way you look at it, numerical control has come of age. It's being used more and more, simply because it produces better, at lower costs. For detailed information, write Jones & Lamson Machine Company, Dept. 710, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 707 on Page 19

Another H&S Speed Reducer

on a *tough* job . . .

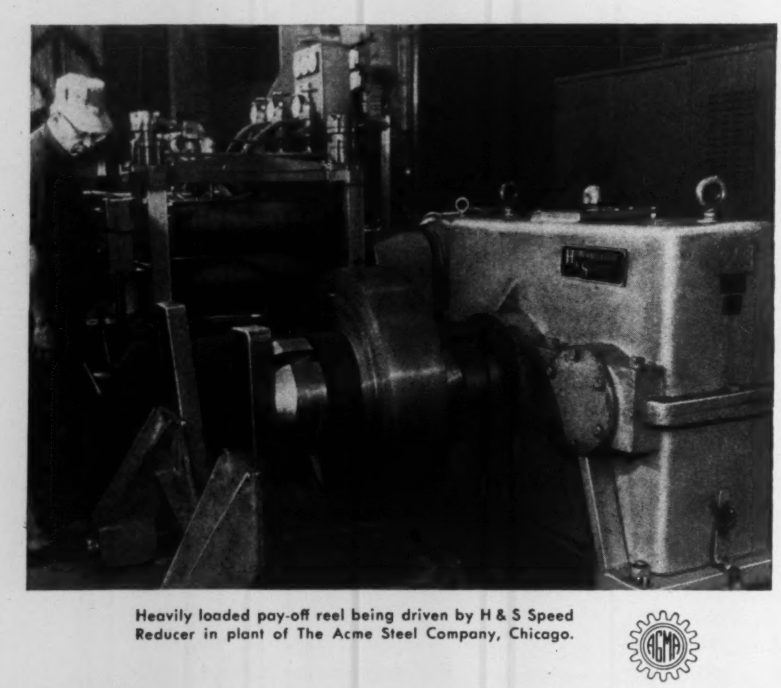
Built rugged for a critical rewind operation, this heavy overhung-load type H & S Herringbone Speed Reducer delivers day-in-day-out service under exacting load conditions.

This standard unit was selected for use on a Bliss precision rewind coiling machine—where strip steel must undergo tension controlled recoiling for subsequent annealing treatment.

Notice the sturdy shaft, with heavy-duty bearings designed to take this heavy overhung load. Observe the rugged housing, made to last.

This built-in toughness typifies H & S construction—on helical, herringbone, worm and combination units.

Send for detailed information on our facilities for producing a complete line of gears and speed reducers in a wide range of sizes and ratings.



Heavily loaded pay-off reel being driven by H & S Speed Reducer in plant of The Acme Steel Company, Chicago.

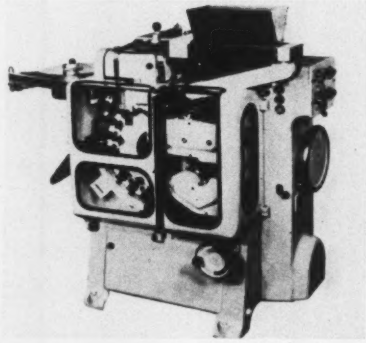
The HORSBURGH & SCOTT CO.
5112 Hamilton Avenue • Cleveland 14, Ohio

Specializing in fast production of quality Speed Reducers and Gearing to meet custom requirements.

Circle 708 on Page 19

any desired proportions. It has a weighing accuracy of ±0.25 per cent of calibrated range; reproducibility is better than one part in 2000. Once the system parameters have been programmed, operation is automatic. The standard readout and control facilities for each ingredient are: Net-weight indication, batch-weight set, tare adjustment, hopper fill and discharge signaling, and control mode selection (automatic, semiautomatic, manual). **Weighing & Control Components Inc.**, 773 East County Line Rd., Hatboro, Pa.

Circle 422 on Page 19

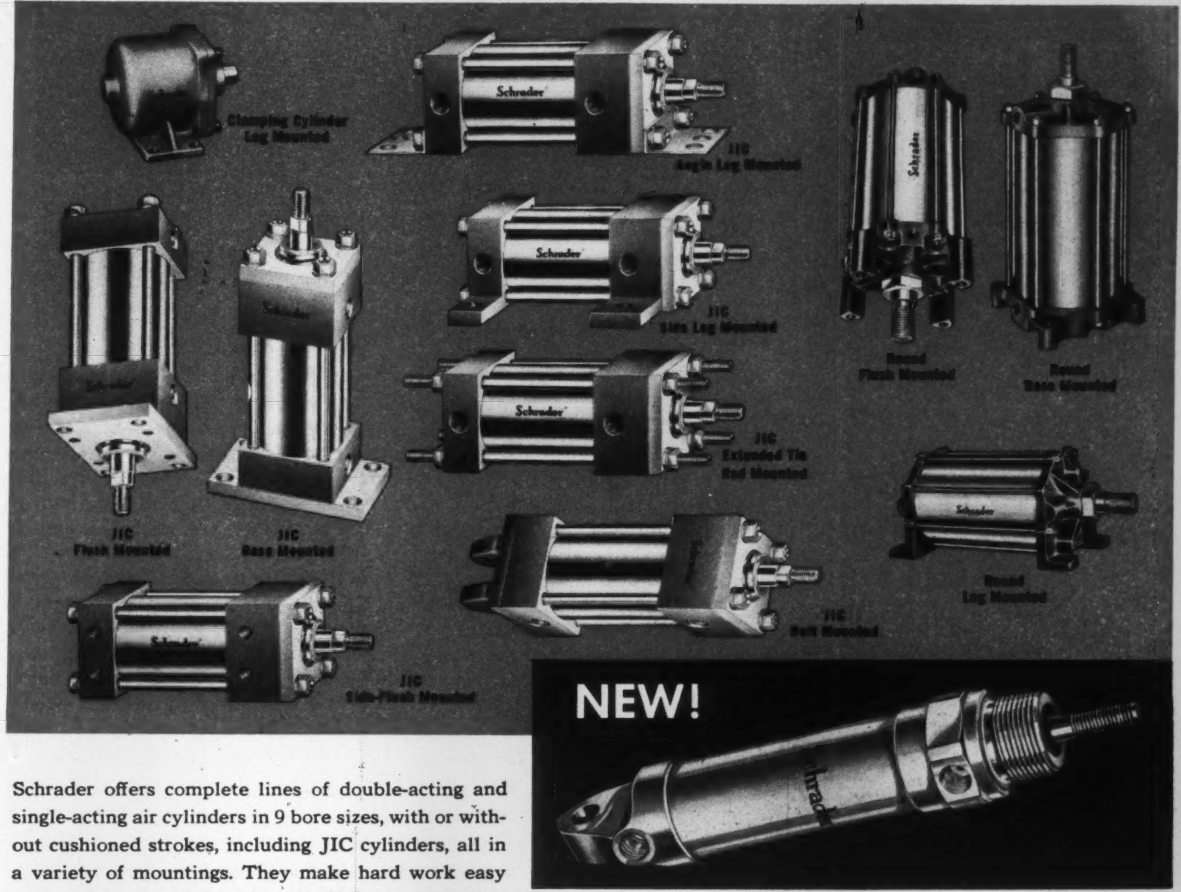


Bunch Wrapping Machine

Unit can wrap up to 550 individual round tablets per minute, the tablet sizes ranging from 3/4 to 1 1/8-inch in diameter and 1/4 to 9/16-inch in thickness. Unprinted or printed wrapping material, cellophane, or waxed paper can be used. Model 87 features continuously rotating feed rollers which operate in conjunction with a rotary knife. The rollers feed wrapping material from a single reel mounted horizontally. Cut wrappers are fed into individual pairs of small grippers mounted on a continuously rotating carrier wheel. Tablets feed vertically from a small hopper into individual pockets in a continuously rotating feed wheel prior to transfer to the wrapping wheel. The wrapper feed, feed wheel, and folding unit are pivotally mounted to swing clear for easy cleaning and maintenance. A rotary oil pump automatically lubricates the main operating parts. **Package Machinery Co.**, East Longmeadow, Mass.

Circle 423 on Page 19

ALL THESE AIR CYLINDERS FROM SCHRADER...

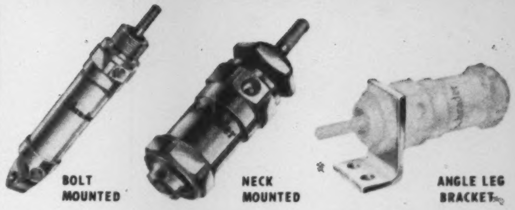

Clamping Cylinder Leg Mounted
JIC Angle Leg Mounted
JIC Side Leg Mounted
JIC Extended Tie Rod Mounted
Round Flush Mounted
Round Base Mounted
JIC Flush Mounted
JIC Base Mounted
Round Leg Mounted
JIC Bolt Mounted
JIC Side-Flush Mounted
Schrader
NEW!

Schrader offers complete lines of double-acting and single-acting air cylinders in 9 bore sizes, with or without cushioned strokes, including JIC cylinders, all in a variety of mountings. They make hard work easy . . . provide powerful push, pull, lift or reciprocating movements . . . and are at work by the thousands in countless plants everywhere.

...AND NOW...POWERFUL NEW MIDGET AIR CYLINDERS

Here they are! Streamlined, compact air cylinders for light duty and gang-type applications . . . rugged . . . only slightly thicker than your thumb! Schrader makes them with strength and precision that will give long trouble-free service even in tough applications requiring extra stamina and speed. Simple to use in any position. Excellent for operating jigs and fixtures, transfer and special purpose machines. Features: No tie rods . . . double-acting . . . popular 1" bore . . . stroke sizes to 12".

Your Schrader distributor is fully stocked with all these air cylinders. He is staffed with factory-trained experts who are fully qualified to help you solve any air control problem and select the right air components to perform jobs best. You'll find him in the yellow pages, or write direct.


BOLT MOUNTED
NECK MOUNTED
ANGLE LEG BRACKET

Schrader's new midget air cylinders have quality built in . . . cartridge type bronze bearing and piston rod seal . . . non-corrodible solid brass end plates with hexagonal flats and non-corrodible brass cylinder and pistons . . . ground and polished steel piston rod . . . molybdenum disulphide grease packing . . . synthetic rubber "U" cup piston seals.

Schrader®
a division of **SCOVILL**

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
472 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

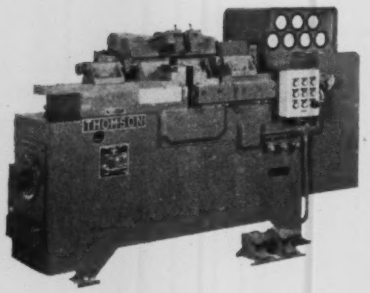
Circle 709 on Page 19

Invented by
THOMSON
Perfected by
THOMSON
Resistance Welding

Spot • Projection • Seam
• Press • Flash-Butt
• High-Frequency

plus
EXCLUSIVE
*Synchro-matic**
and
Synchro-shear

...for jobs no other resistance welders can do



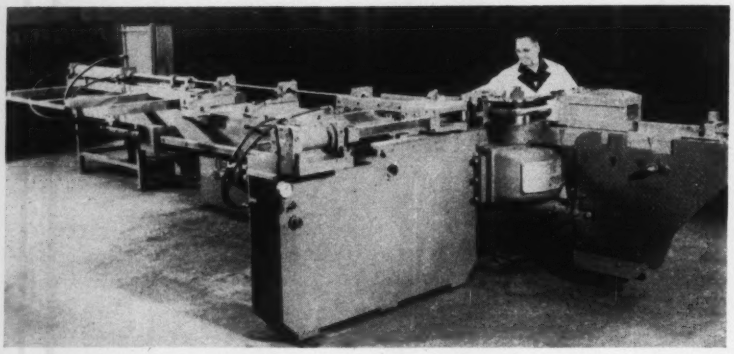
THOMSON QUALITY is so important that we build our own transformers to assure maximum performance and reliability. For all **AUTOMATED** and **HIGH-PRODUCTION** requirements — either special or standard design — **THOMSON QUALITY** is within your budget. A **THOMSON** quote will prove it.

* patented

Look for our nearest representative in the yellow pages or contact —

Inventor of Resistance Welding
THOMSON ELECTRIC WELDER COMPANY
161 PLEASANT STREET, LYNN, MASSACHUSETTS
LYnn 2-7710

Circle 710 on Page 19



Tube Bending Machine

Hydraulic benders are available in four sizes for tubing of 1½, 3, 6, and 8 inches in diameter. The machines will bend repeatedly to ±¼ degree accuracy in 180 degrees with radii as small as 1 diameter. A direct-acting pressure die accessory reduces setup time and also reduces the tendency for tubing to wrinkle or rupture during a bend as it applies pressure directly in line with the tube centerline, and automatically compensates for slight variations in wall thickness or minute machine or tooling deflections. This die accessory is especially suitable for thin-wall tubing, as the retaining force applied by the pressure die is the force that produces the bend.

The hydraulic cylinder for the pressure die is mounted on top of the stationary arm of the machine. It applies force in a straight line to the centerline of the tube through the pressure die. Other features of the machine include: Hand scraped ways, slides, and die mounting surfaces, calibrated scales, and push-button control of all machine operations. **Pines Engineering Co. Inc.,** 601 Walnut St., Aurora, Ill.

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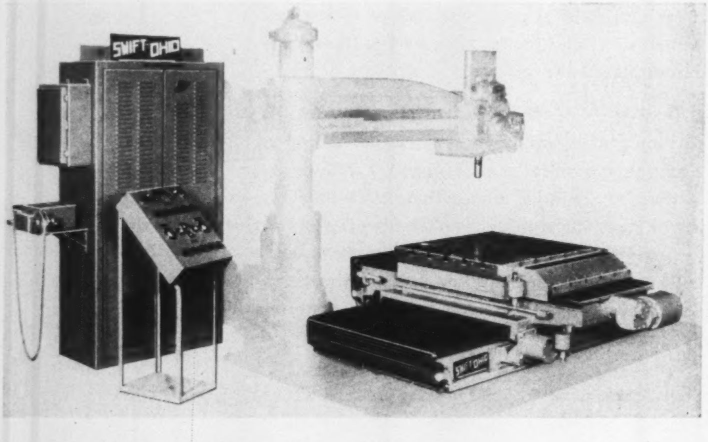


Numerically Positioned Table

Numerically positioned controlled compound indexing table can be used with radial drills, upright drills, and horizontal boring and drilling machines. Construction of the table unit allows for work loads up to 4000 lb capacity and drilling thrusts of 5000 lb. The table unit is designed to allow for many variations in table size and length of travel. Maximum deflection of the table unit with work load is 0.001 inch, with traverse rate of 150 ipm. Ten machined accurate tee slots allow for easier positioning of workpieces on the table top. Electrical

Circle 711 on Page 19→

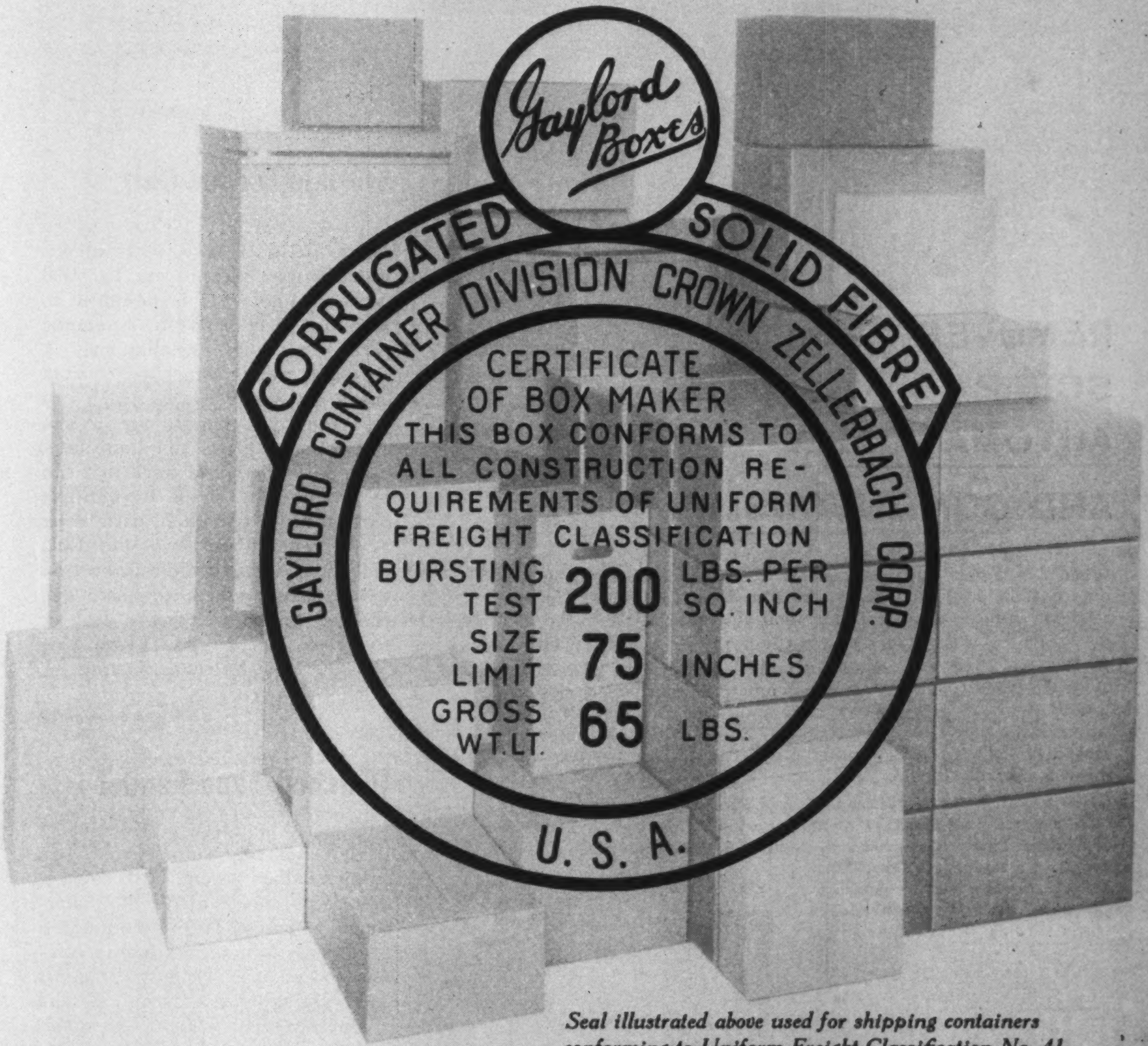
This is only one proof of GAYLORD quality

Here you read the measurable qualities in Gaylord Containers.

But how do you measure experience and ingenuity . . . which are *extra* qualities built into every Gaylord box?

Gaylord is part of a completely-integrated, nation-wide organization of packaging talents, devoted to delivering the most efficient, most economical container you can buy.

Your nearby Gaylord Man can prove this. Why not let him try?



Gaylord Boxes

CORRUGATED SOLID FIBRE

GAYLORD CONTAINER DIVISION CROWN ZELLERBACH CORP.

CERTIFICATE
OF BOX MAKER
THIS BOX CONFORMS TO
ALL CONSTRUCTION REQUIREMENTS OF UNIFORM
FREIGHT CLASSIFICATION

BURSTING TEST	200	LBS. PER SQ. INCH
SIZE LIMIT	75	INCHES
GROSS WT. LT.	65	LBS.

U. S. A.

Seal illustrated above used for shipping containers conforming to Uniform Freight Classification No. 41.

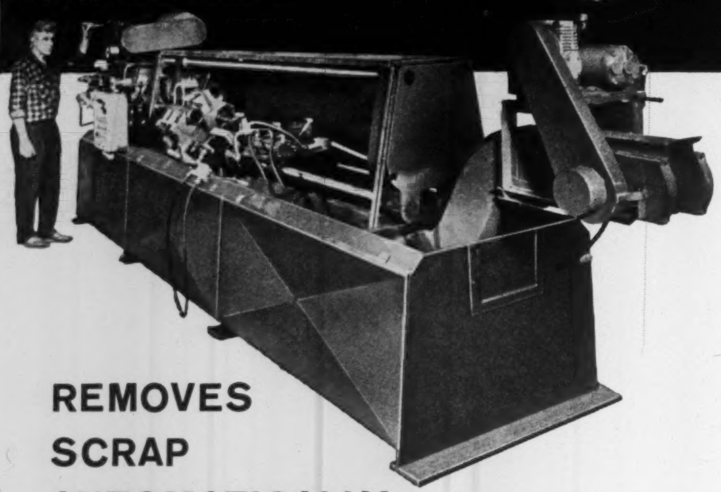
CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

IN CANADA · CROWN ZELLERBACH
CANADA, LTD. VANCOUVER, B. C.

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

MAY-FRAN CHIP-TOTE

PROVIDES ADDED VERSATILITY FOR HILL DRILL



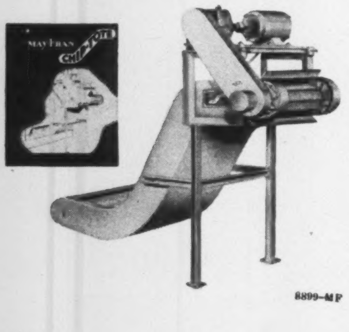
REMOVES SCRAP AUTOMATICALLY AND CONTINUOUSLY!

When continuous high-speed metal working operations mean the difference of profit or loss . . . the May-Fran CHIP-TOTE stands ready to remove scrap efficiently and automatically.

In the photograph above, the HILL-DRILL (a product of Walter P. Hill Inc.) is shown equipped with a May-Fran CHIP-TOTE. This accessory unit was fabricated into the machine prior to delivery to customer. Every day, more and more machine tool manufacturers are specifying the CHIP-TOTE to provide their automatic machines with virtually unlimited production without need for shutdown for scrap removal.

CHIP-TOTE scrap handling units are available for attachment to almost every kind and type of machine tool in use today. They are assembled from mass-produced component parts to meet a wide range of varying specifications.

If you have a scrap handling problem involving wet or dry chips turning or borings, write today for your copy of MF-640 which describes the CHIP-TOTE in detail.



MAY-FRAN
ENGINEERING, INC.
1761 Clarkstone Rd. • Cleveland, Ohio

8899-MP

Circle 712 on Page 19

accuracy of the table unit is ±0.0005 inch, with an absolute accuracy of ±0.0015 inch on drilled hole location. **Swift Ohio Corp.,** 800 S. Leighton, Kenton, Ohio.

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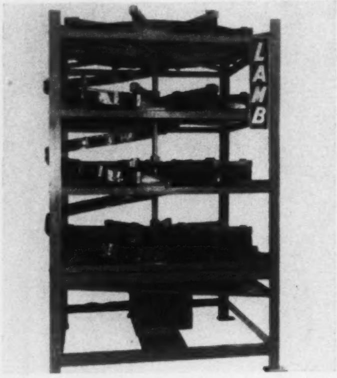


Storage-Feeder Unit

Storage-feeder unit has up to 12,000 parts capacity, with an adjustable feed rate of up to 6000 parts per hour. It is designed to bank or feed parts in automatic parts handling installations. A standard unit is comprised of from one to six storage decks which can be arranged to handle one or several different parts simultaneously. Each deck is a spiral track that can be wound into single or multiple part lanes. In operation, parts enter at the outer diameter of the deck, and travel through the spiral course to the center where they are discharged to the next lower deck or to processing. **F. Jos. Lamb Co.,** 5663 E. Nine Mile Rd., Detroit 34, Mich.

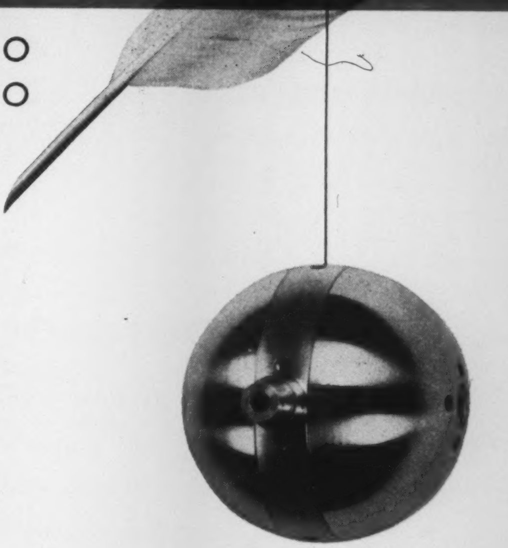
Circle 426 on Page 19

Punched Tape Reader

Punched tape reader (Model 909) has a completely transistorized electronic readout system. It is capable of reading speeds up to 1000 characters per second and stop on a *Stop* character. When used with a companion spooler mechanism (Model 3299), reading speeds up to 200 characters are possible. The spooler can accommodate paper or mylar tape up to one inch in width on eight inch diameter reels. **Potter Instrument Co. Inc.,** Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 427 on Page 19

PRECISION:



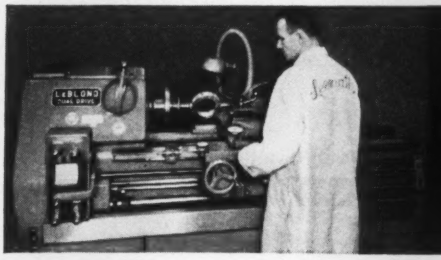
Beryllium specialists, Leemath Incorporated of Long Island, create delicate and precise mechanisms in this high strength but toxic and abrasive wonder metal. In their temperature-controlled shop, this feather-light gyro float assembly (shown actual size, right) was turned on a special high-precision LeBlond Dual-Drive Lathe. *Spherocity had to be concentric with the two major axes within .0005" total indicated runout of 1.8750"!* (To hold the assembly that close, component tolerances had to be even tighter!)

To perform such touchy work, Leemath ordered their LeBlond 15" Dual-Drive to ultra-high precision standards. For this lathe Timken furnished specially-made bearings with one-third the runout of their finest precision class. With it came the standard features that give LeBlond its reputation for long-lived precision —combination gear-belt drive headstock with 16 speeds, 31 to 2400 rpm; compensating vee bed way construction with hardened steel shears; thrust-lock tailstock; and many more.

People buy lathes for many reasons. But when, like Leemath, they must have precision they can depend upon, that is reason enough to buy LeBlond.

If you would like to have the full story of LeBlond's Dual-Drive, ask your distributor or write for Bulletin 6A.

Reason enough to buy LeBlond



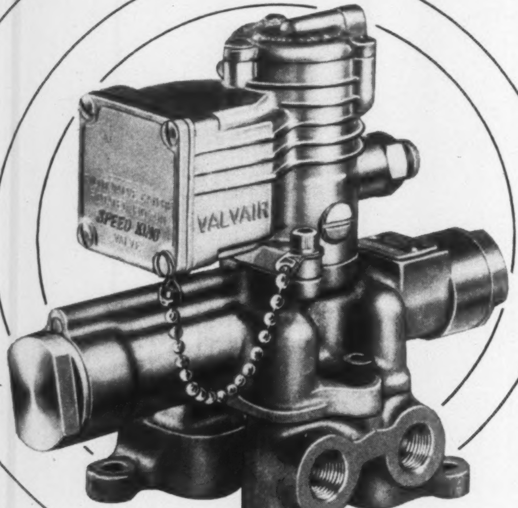
THE R. K. LeBLOND MACHINE TOOL COMPANY
Cincinnati 8, Ohio

LeBLOND
of Cincinnati

Circle 713 on Page 19

No coil burnout with

SPEED KING®



...pilot operated control valves

• Built to JIC standards • interchangeable pilots • choice of mounting types, optional features • ac or dc, any voltage • ¼ to 1 in. NPT

SPEED KING solenoid pilot coils, potted in molded resin, are unconditionally guaranteed against coil burnout for the life of the valve! And, Speed King pilots are totally enclosed, and sealed against entrance of dirt or moisture . . . valves are fully air-operated for speed and dependability . . . feature a hard-chrome plated stainless steel plunger floating in O-rings, to eliminate wear-producing metal-to-metal contact.

For multi-million cycle dependability, specify Valvair® SPEED KING control valves.

Write for free Bulletin SK-100.
Address: Valvair Corp., Akron 9,
Ohio, Dept. AU-460

Valvair AKRON 11, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)
Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co.
The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

CONTROLLED · AIR · POWER DEVICES
Bellows-Valvair
FOR FASTER · SAFER · BETTER PRODUCTION

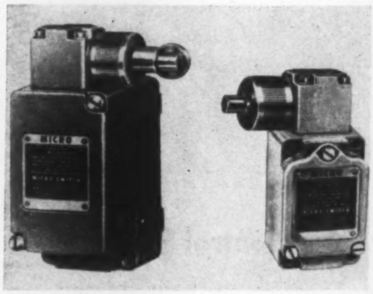
8111

Circle 714 on Page 19

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

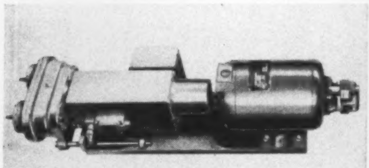
For detailed information and literature, use card page 19.



Side-Plunger Switches

Heavy-duty side plunger limit switches are available in both plug-in and permanent-mount housings. The side plungers allow the switches to be placed in cramped quarters around cams and slides. Actuator heads can be rotated to face in four directions—to the front, back, or either side. The rollers on roller-plunger actuators can be locked at any angle with respect to the switch centerline. Contact arrangement for these switches is 2-circuit, double break. **Micro Switch, Div., Minneapolis - Honeywell Regulator Co.,** Freeport, Ill.

Circle 428 on Page 19



Drilling Unit

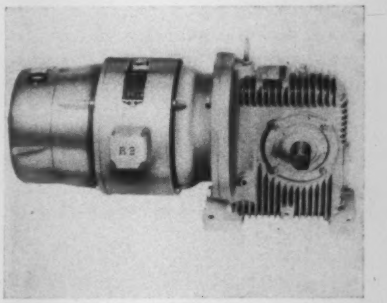
Hydraulically actuated unit can be furnished as a single spindle or with multiple spindle drill heads. The self-contained unit, powered by a ½ hp, 1800 rpm motor, has a thrust capacity of 600 lb, spindle speed of 2000 rpm, and a cycle time of 2 seconds for a 3-inch forward and return stroke. The unit, designated E.J.S. Junior, can be mounted in any position. **John S. Barnes Corp.,** 315 S. Madison St., Rockford, Ill.

Circle 429 on Page 19

Frequency Counter

Instrument automatically measures frequency and random events per unit of time. With transducers, it provides measurements of mechanical quantities such as speed, rpm, rps, weight, pressure, temperature, and acceleration. Frequency range of Model 521G is 1 cps to 1.2 mc, with an accuracy of ±1 count. Display time is adjustable to approximately 15 seconds, or readings can be held until manually reset. Counter has a front panel switch for selecting automatic gate times of 0.1 sec, 1 sec, or the manual gate. **Hewlett-Packard Co.,** 275 Page Mill Rd., Palo Alto, Calif.

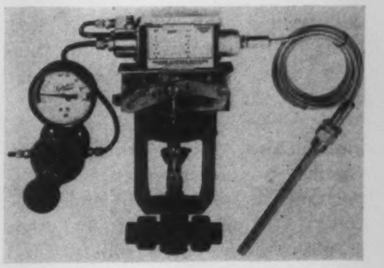
Circle 430 on Page 19



Worm Motor Reducer

Double-enveloping worm motor reducer features a worm and gear mating principle which gives full-depth contact of worm and gear teeth, as well as increasing the number of teeth in mesh. The unit is available in horsepower ratings from ½ through 15 hp. Speed reduction ratings, from rated motor speeds, are 525 through 7.3 rpm. Mounting styles can be feet, hollowshaft, or flange. A selection of drive motors is available. **Reuland Electric Co.,** Alhambra, Calif.

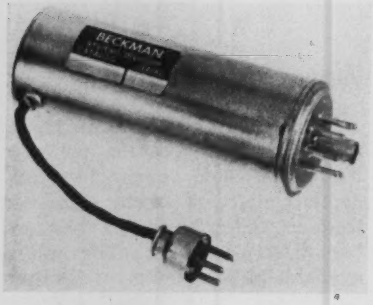
Circle 431 on Page 19



Pneumatic Controller

Combination controller-positioner-valve unit features an automatic reset. It can perform the functions of measurement, control point setting, modulating control, adjustable proportional band, and positive valve positioning. When used with a pneumatic transmitter as a control valve (having a positive positioner), it can control variables such as rate of flow, liquid level, or temperatures and pressures beyond the range of its own vapor-pressure temperature elements or bellows pressure elements. Another feature is the remote pneumatic control point adjustment. The control setting can be adjusted from the remote loading station, which can be located 1000 feet away. The indicating dial thermometer can be directly mounted or it can be furnished for remote mounting up to 10 feet away from the control. **Fulton Sylphon Div., Robertshaw-Fulton Controls Co.,** Box 400, Knoxville, Tenn.

Circle 432 on Page 19



Mercury Relay

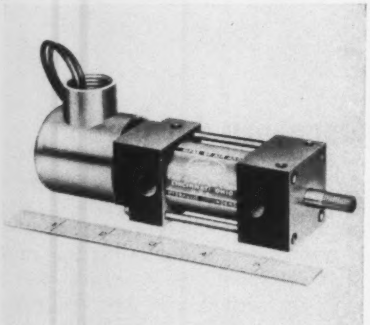
Relay is suitable for use in low-level multiplexing and precision switching applications, operates smoothly at frequencies up to 100 cps. Switching time is less than 3 milliseconds each way (make and break) and mercury bridging time is less than 1 millisecond. Switch arrangement is SPDT, make-before-break. The unit, designated Flocon, has shielded, truly floating contacts which introduce less than 1 uuf capacitance between signal and relay coil. The mercury-wetted design eliminates bounce and chatter and minimizes arcing, even under conditions of vibration or shock. Leakage resistance exceeds 150 megohms. **Systems Div., Beckman Instruments Inc.,** 325 N. Muller Ave., Anaheim, Calif.

Circle 433 on Page 19

Magnetic Amplifier

Device is designed to amplify the low signal values derived from a photo - multiplier tube, thermocouple, or other sensing device. Amplifier outputs for Model 1532 are 0-1 ma dc for any signal input from 0-1 microamp to 0-60 microamps. Potentiometers for adjustment are internally mounted with screwdriver set devices with shaft locks protruding from case. Amplifier ranges can be set to intermediate values by adjusting potentiometers. Output linearity is ±1 per cent of full scale; output gain stability is ±2 per cent of full scale over specified temperature range. The drift does not exceed ±3 per cent of full scale with combinations of voltage and ambient temperature changes. Instrument operates on 115 v ±10 per cent, 60 or 400 cps. **Lumen Inc.,** Moen Ave., P. O. Box 905, Joliet, Ill.

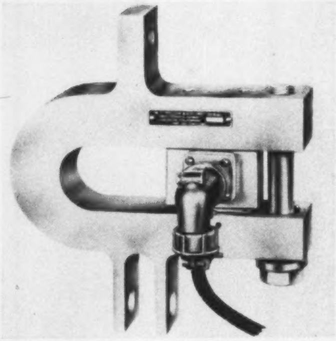
Circle 434 on Page 19



Clamp Type Cylinder

Clamp type cylinder features an integral solenoid operated valve. It is furnished in $1\frac{1}{8}$-inch bore size, for 150 psi air or 250 psi oil or water service. The cylinder is available in spring return or double acting style, with 1, 2, or 3-inch strokes. It will operate on 115 v, 60 cycles, continuous duty operation at temperatures up to 180 F, with power consumption rated at 10 w. **Sheffer Corp.,** 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 435 on Page 19



Force Control Switch

Unit automatically triggers operations at various load points, is adaptable to heavy duty service or continuous outdoor application. In operation, the *U* shaped beam moves outwardly. Switches contained in the housing at the center are actuated at various preset load points by means of recessed adjustment screws located in the lower half of the beam. As many as four limit switches, operating separately or at the same load point, can be furnished with this unit. The switches are completely enclosed in a dust and moisture-proof case. **W. C. Dillon & Co. Inc.,** 14620 Keswick St., Van Nuys, Calif.

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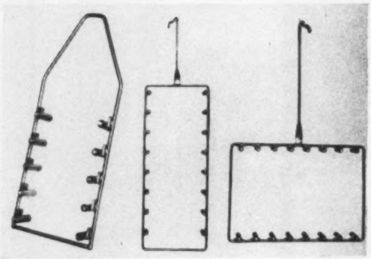


Magnetic Racks

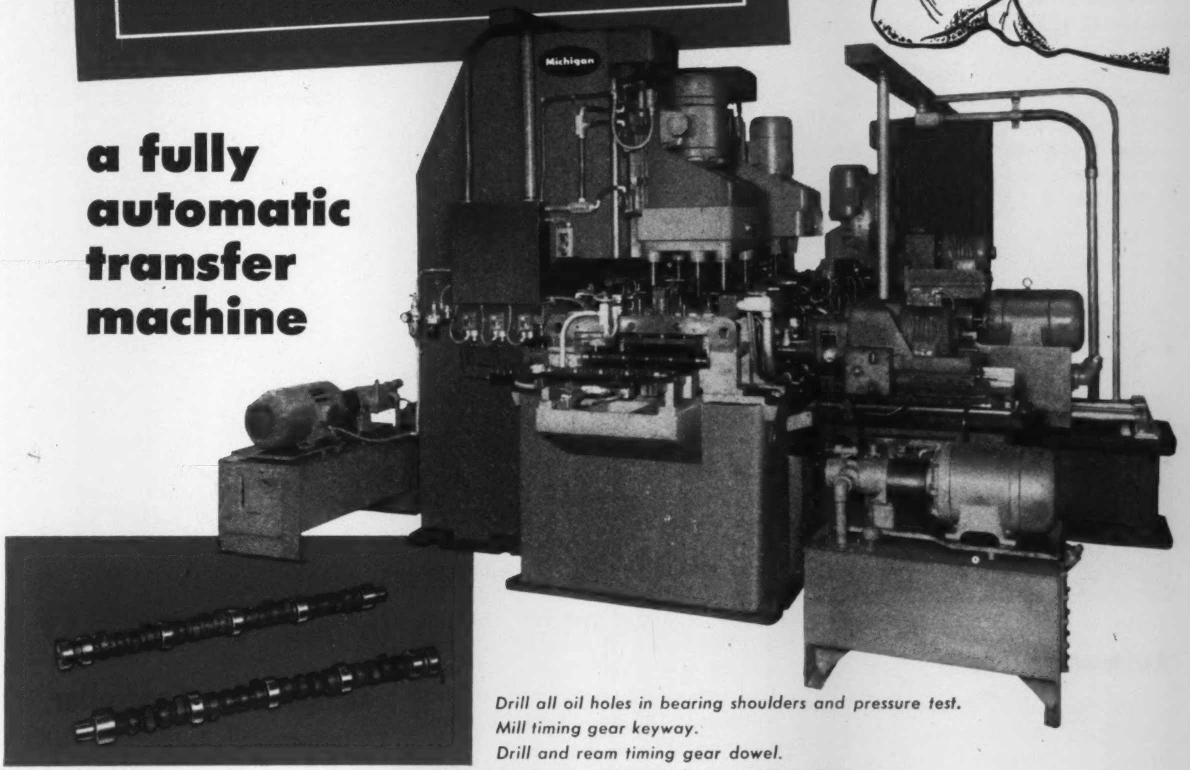
Hanging magnetic racks can be used with overhead or monorail conveying systems. They will

AUTOMATION

"CAMSHAFT"

by MICHIGAN

a fully automatic transfer machine



Drill all oil holes in bearing shoulders and pressure test.
Mill timing gear keyway.
Drill and ream timing gear dowel.
Production 180 per hr. at 100% efficiency.

it provides a complete oil system in 20 operations!

The first 3 operations are performed in the initial radial position; the next 7 operations, after indexing the camshaft 46°; and the last 10 operations, after indexing the camshaft an additional 115°.

it's compact automation — for limited floor space!

It's a 12-station Transfer Machine, designed for a production line operation — And, it will fit in a floor space of only 14′ x 22′.

it's fully automatic — including load and unload!

All the components, as well as the transfer, locating, and clamping mechanisms, are hydraulically operated and electrically controlled.

and, it's built around standard michigan components!

You'll enjoy substantial savings in machine cost, too, because it's built, fully 70%, from our own Standard Michigan Components.

for faster, More Economical Production

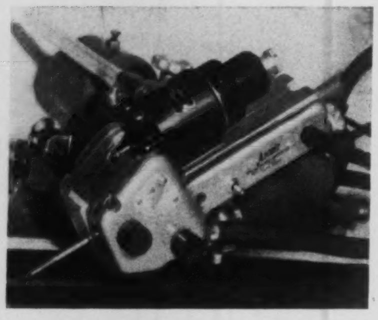
Michigan SPECIAL MACHINE CO.

Engineers and Manufacturers of High Production Metal Cutting Machines and Components.
11449 TIMKEN AVE., WARREN, MICHIGAN

Circle 715 on Page 19

handle all sizes and shapes of parts for operations such as dipping, spray painting, washing, coating, or plating. The units, designated Magna-Rax are composed of a steel frame of appropriate design to which are welded, as attaching members, a battery of permanent double-ended magnets. Large units, such as a car door, can be securely held and conveyed through an operation. By the use of auxiliary ferrous hangers, held by the magnets, small objects can be handled with maximum flexibility of arrangement. Construction of the racks resists rust and oxidizing and they can tolerate temperature to 750 F. **Eriez Mfg. Co.**, Erie 6, Pa.

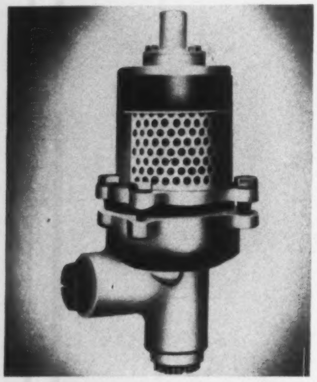
Circle 437 on Page 19



Automatic Torch

Portable unit is designed to prepare joints for welding. It performs all mechanized grooving, deseaming, and plate edge preparations. Model Q-3 consists of a head with an electrode feed mechanism which feeds consumable copper coated carbon-graphite electrodes as required and supplies a jet of air at the proper location. The head is mounted on a tractor permitting straight line or circular travel at a predetermined speed. When the work is positioned, the head can be removed from the tractor and mounted on the positioning equipment in the same manner as an automatic welding head. The head can be set at any angle with the work to produce a variety of grooves and bevel contours. It can handle electrodes from 3/16 to $\frac{3}{8}$ inch diameter. The tractor has a speed range of zero to 180 inches per minute. **Arcair Co.**, Box 431, Lancaster, Ohio.

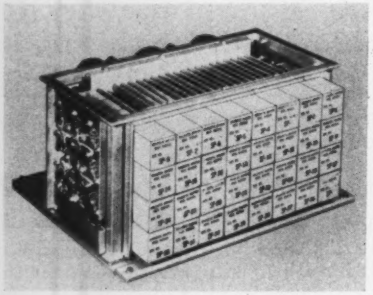
Circle 438 on Page 19



Pressure Regulator

Pneumatic pressure regulator can maintain pressure within $\frac{1}{2}$ psi over normal flow ranges and within $\frac{1}{4}$ psi over altitudes ranging from sea level to 90,000 ft. Unit is available in any value in the range from 14.7 to 100 psi absolute. It is operable with supply air pressures ranging from 14.7 to 315 psi absolute and with supply air temperatures ranging from −100 to 700 F. The unit can operate in ambient temperatures ranging from −100 to 275 F. Air flow capacity ranges from zero to 40 cubic feet a minute, depending on the relationship between regulated pressure and supply pressure. Regulator has provisions for an integral relief valve and for remote sensing of ambient pressure. **Consolidated Controls Corp.**, Bethel, Conn.

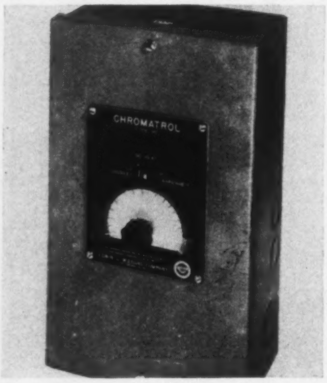
Circle 439 on Page 19



Static Time Sequencer

Self-contained programmer provides control/power signals for automatically performing test operations. System design of Model MA-6011 is completely solid state with the exception of long life beam switching tubes (50,000 hr) which are used for distributing the time signals. Heart of the sequencer is the Stat-Pack magnetic switches which operate in conjunction with printed circuit logic modules, and provide switched outputs at predetermined time intervals. The logic modules are capable of performing any of the principal logic functions such as *And, Or, Not,* and *Memory,* in addition to *Time Relay*. A dual time channel is included to provide time verifications for each magnetic switch output. **Magnetic Amplifiers Inc.**, 632 Tinton Ave., New York 55, N. Y.

Circle 440 on Page 19



Temperature Controller

Instrument is designed for highly-sensitive temperature control from 25 to 600 F. The thermistor-probe can be located in platens, in air ducts, and in immersion wells and connected to an amplifier-relay cabinet as much as 100 feet away. When sensing temperatures within rotating equipment, the thermistor leads can connect via slip-rings. Heater loads up to 10 kw can be controlled directly without the need for separate magnetic contactors. Model PC-6 can be used on 105 v to 250 v, 60 cycles. The control box can be mounted on an oven wall, duct, or in other locations with ambient temperatures from zero to 150 F. The scale covers a dual-range from 25 to 225 F or 200 to 600 F. The dial-plate control is removable from the amplifier-relay for remote location up to 30 feet away. **Edwin L. Wiegand Co.**, 7500 Thomas Blvd., Pittsburgh 8, Pa.

Circle 441 on Page 19

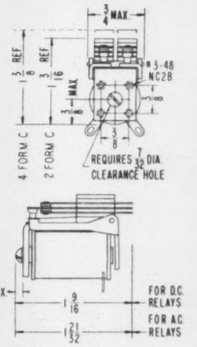
COMPACT, RELIABLE, VERSATILE . . .
this is P&B's miniature MH relay

The MH is not a new relay.

As a matter of fact, we've been building and selling this series for seven or eight years. Its reliability and exceptional longevity have been proved in business machines, airborne computers and a host of other products.

Engineers like its fast action, its small size, its light weight. They like the wide selection of contact forms . . . up to 18 springs (9 per stack, DC) as well as the fact MH relays can be furnished to switch loads ranging from dry circuit to over 5 amps at 115 volts, 60 cycle resistive.

A multiple choice of terminations add to the MH's versatility. This relay, for example, can be adapted for printed circuits, furnished with taper tabs or a long list of other terminals. Get all the facts by calling your nearest P&B sales engineer today.



MH ENGINEERING DATA

GENERAL:

Breakdown Voltage: 500 volts RMS between all elements.

Ambient Temperatures: −45° C to +85° C. (−65° C to +125° C on special order.)

Shock: 30g on special order.

Vibration: 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps. on special order.

Weight: 2½ ozs. max. (open relay)

Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:

Arrangements: Up to 9 springs per stack.

Material: 1/8" silver standard: Palladium or gold alloy also available.

Load: Dry circuits to 5 amps @ 115V AC res.

COILS:

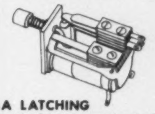
Resistance: 22,000 ohms max.

Power: 100 mw per movable min. to 4 watts at 25° C max. (200 mw min. to meet max. shock/vibration spec.)

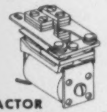
Duty: DC: Continuous. AC: Intermittent (Two pole relay max.) open. Sealed units supplied with full wave rectifier inside can.

Voltages: DC: Up to 110 volts. AC: Up to 230 volts 60 cycles.

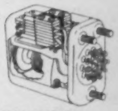
The relays below are variations of the MH relay structure.



MA LATCHING
Electrical latch, mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.



MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

Circle 716 on Page 19

Reduce small parts handling costs!
New RCA
Orienting Belt Elevator
for high-speed feeding of parts

Built to handle a wide variety of parts—sizes and shapes—the OBE's versatility and rugged design make it a valuable asset in integrating and automating production line operations. Even and continuous flow is provided. Costly and tedious manual operations are eliminated.

Special Features Include:

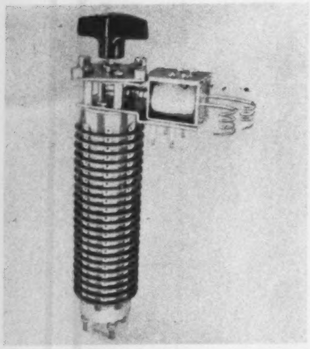
- High-speed feeding of a wide range of part sizes and shapes.
- Variable discharge track height.
- Variable speed drive to meet machine demands.
- Large storage capacity.
- Automatic feed controls and special orientation devices available. Right- or left-hand discharge to suit your needs.
- Rugged construction — standard components.
- Ease of maintenance—all parts readily available.

Write for complete details on the new RCA Orienting Belt Elevator. Also ask about RCA's full line of automatic feeding equipment.

RCA Tmk(s) ®

RADIO CORPORATION of AMERICA
INDUSTRIAL AND AUTOMATION DIVISION
12611 Arnold Avenue • Detroit 39, Michigan

Circle 717 on Page 19



Solenoid Lock

Solenoid locking mechanism is designed for company's multipole rotary switch, and will lock every position of the switch so that no setting can be changed until the solenoid lock is released. It can also be provided with some positions locked and the rest free for local control. Release can be effected by energizing the solenoid or, where fail-safe protection is required, by de-energizing the solenoid. Coils are available for 12-24-115 v dc operation and can be impregnated to meet MIL-T-152. The eight-position switch can be furnished in 5, 10, 15, 20, or 25-section assemblies, with a wide variety of contact arrangements. **Electro Switch Corp.**, King Ave., Weymouth, Boston 88, Mass.

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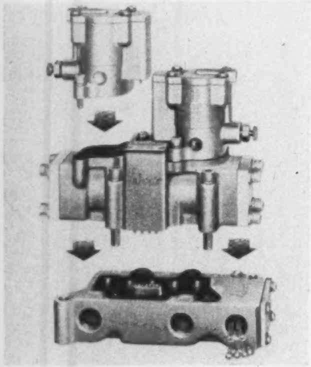
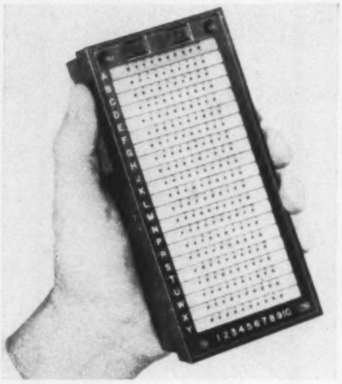


Plug-in Valve

Line of single and double solenoid plug-in type 4-way control valves features one-piece solenoid pilot housings. The valves, designed for a range of 35-200 psi air service, are available with solenoid coils for ac or dc, any voltage or cycle. Flow area through the valve and sub-base equals that of full $\frac{1}{2}$-inch pipe. The pilot plungers and main valve stem are the only moving parts and no springs are used in the main valve body. All power connections are made in the manifold or sub-base and need not be disturbed for maintenance. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 443 on Page 19



Static Control

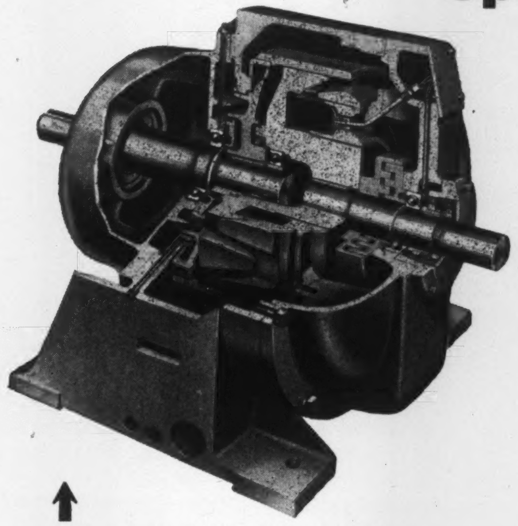
Line of color-coded static control components can accomplish logic functions such as *And, Or, Not,* and *Memory*. Unit, designated Norpak, provides switching rates up to 25,000 per second. The components are available separately, or in 6 or 20 packs. They can be applied as desired without regard to phase sensitivity. Tapered pin connections assure positive external circuits. Optional equipment available includes monitor lights which give visual indication of proper performance and a dynamic sequence tester which checks individual units in operation. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 444 on Page 19

Code Drums

Code and switching drums with imbedded circuits are applicable in telemetering and control devices. The standard drum has a code pattern capable of 207 separate character combinations, plus an identifying code for the user. It has brass contact areas (silver, gold, or

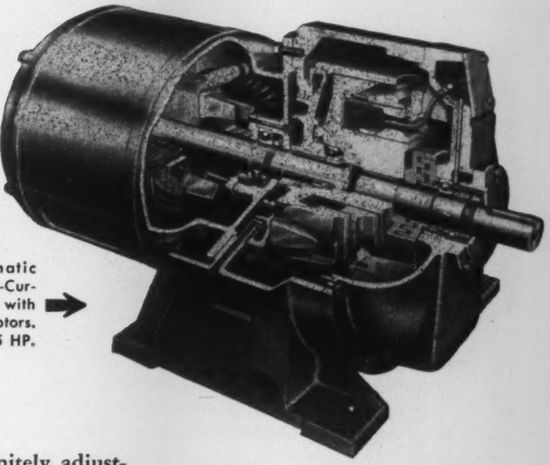
The BEST Solution to Difficult Speed Control Problems—



EATON DYNAMATIC®

LIQUID-COOLED EDDY-CURRENT COUPLINGS and DRIVES

Dynamatic Liquid-Cooled Couplings provide infinitely adjustable speeds for nearly every application from 3 to 75 HP. Note the absence of slip rings, brushes, and commutators. Heavy-duty types with capacities up to 5,000 HP are also available.



"Dynaspede" Drives are Dynamatic Liquid-Cooled, Stationary-Field Eddy-Current Couplings mounted integrally with standard, D-flange, squirrel cage motors. Available in capacities from 3 to 75 HP.

Here's Why—

Dynamatic Liquid-Cooled Couplings and Drives provide infinitely adjustable speed from a constant speed source—or constant speed from a variable speed source. They operate on standard alternating current. Rotary power is transmitted through the coupling by an electromagnetic reaction between the driving and driven members of the unit—there is no mechanical contact of rotating members to cause wear and require adjustment or replacement.

A wide range of standard and special control features may be obtained from a remotely-mounted electronic control system. Infinite speed adjustment, constant speed control, on-off clutch control, torque limit, acceleration control, inching, and threading are a few of the many functions available. The addition of an eddy-current brake to standard couplings or drives provides smooth, cushioned stops and controlled deceleration.

Liquid-Cooled Dynamatic Couplings and Drives deliver more horsepower than other types of the same physical size, thus conserving space in a busy machine area. Efficient heat dissipation permits continued operation at low speeds, or stall with full load.

Completely enclosed, Dynamatic liquid-cooled units are protected from dust, dirt, and other atmospheric impurities. Dynamatic design involves no brushes or slip rings; there is no possibility of arcing. With simple modification these units can be made explosion-resistant for hazardous applications.

Infinitely Adjustable Speeds from AC Power

★

Full-Torque Starts

★

Wide Range of Control Functions

★

No Slip Rings, Brushes or Commutators

★

Completely Enclosed Design

★

Low-Cost Maintenance

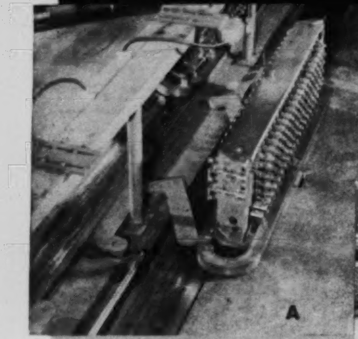
Send for Our New Illustrated Bulletin.

EATON

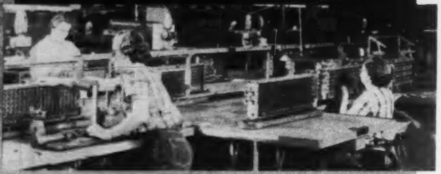
DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

SANDVIK

STEEL BELT CONVEYORS



Make More Kinds
Of Automation
Possible

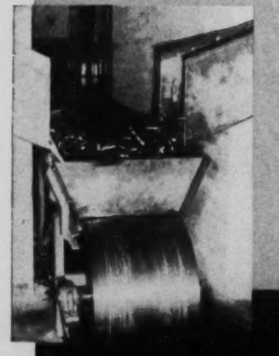


At Western Electric's Omaha Works, Sandvik "Tru-Track" steel belt conveyors 130′ and 150′ long are used in assembly tables for crossbar switches. These switches weigh up to 57 pounds and are mounted on roller carriages for rolling on and off the moving steel belt. Photo (A) shows how pneumatically-operated pusher arms move carriage off belt at each work station. Pushers are actuated by a limit switch tripped by a removable magnet on top of unit.

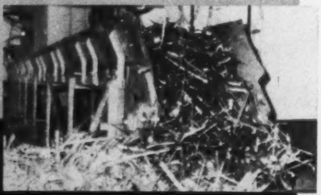
The inherent abilities of the solid, cold rolled carbon steel band used on Sandvik conveyors open the way to new automated operations.

The smooth, hard, impervious surface of the flat steel belt:

- Resists Oil, Heat and Abrasion
- Simplifies Automatic On-Off Sliding and Live Backlogging
- Can Be Easily Fitted With Simple Guide and Discharge Devices
- Has High Load Capacity and Long Service Life
- Belt Can Be Any Length



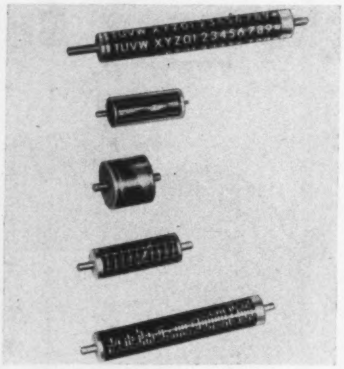
Sandvik "Tru-Track" steel belt conveyor handling metal scrap. Accurate, straight-line tracking of belt combined with angled side plates prevents pieces from getting wedged between side plates and belt . . . thus making automated operation possible.



SANDVIK STEEL BELT CONVEYORS

SANDVIK STEEL, INC.
Steel Belt Conveyor Department
1702 Nevins Rd., Fair Lawn, N. J. SWarthmore 7-6200
Cleveland • Chicago • Detroit • Los Angeles
IN CANADA: Sandvik Canadian Ltd., P.O. Dr. 1335, Sta. O., Montreal 9, P.Q.

Circle 719 on Page 19



rhodium plated), brass shaft, epoxy filler, and measures 1-inch in diameter by 2½ inches in length. Other types of units available are: Sequential code drums used to control sequential switching operations, special cycle drums used for delicate measurements, and code character drums used with automatic typewriter equipment. **Beck's Inc.**, 300 E. Fifth St., St. Paul 1, Minn.

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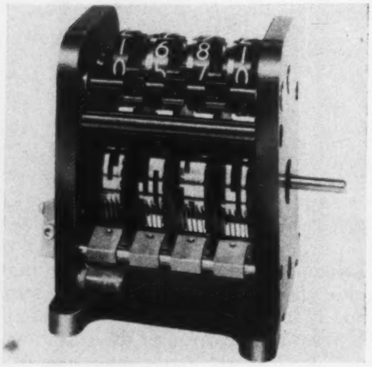


Direct Drive Counter

Instrument provides simultaneous readouts in both visual and digital form. It can be used to transmit coded signals to any remote location for use as input to devices such as computers, business machines, tape punch recorders, card punchers, digital printers, servomechanisms, integrators, and meters. The direct reading analog-to-digital converter has a digitalizing capacity of 0000-9999 and a resolution of 1 bit per 10,000 bits. The input driving torque is 2 in. oz; input shaft rotation is 250 rpm, maximum. **Kearfott Co. Inc.**, 1500 Main Ave., Clifton, N. J.

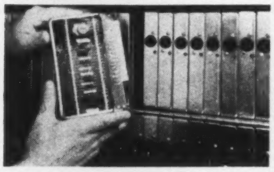
Circle 446 on Page 19

Hughes, a world leader in electronics, brings you:

ALL-ELECTRONIC NUMERICAL CONTROL

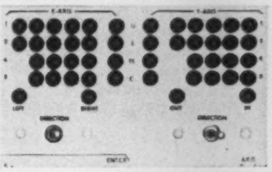
for *fast, accurate, trouble-free positioning.* Designed with the customer in mind, and backed by experience gained from many years as a leader in research, development and production in the advanced electronics field, the new *all-electronic* Hughes Numerical Control offers you:

Trouble-free operation; easy electrical maintenance: Transistorized circuitry and modularized construction assures you uninterrupted production with low power consumption; simple replacement and repair. *No service contract needed!*

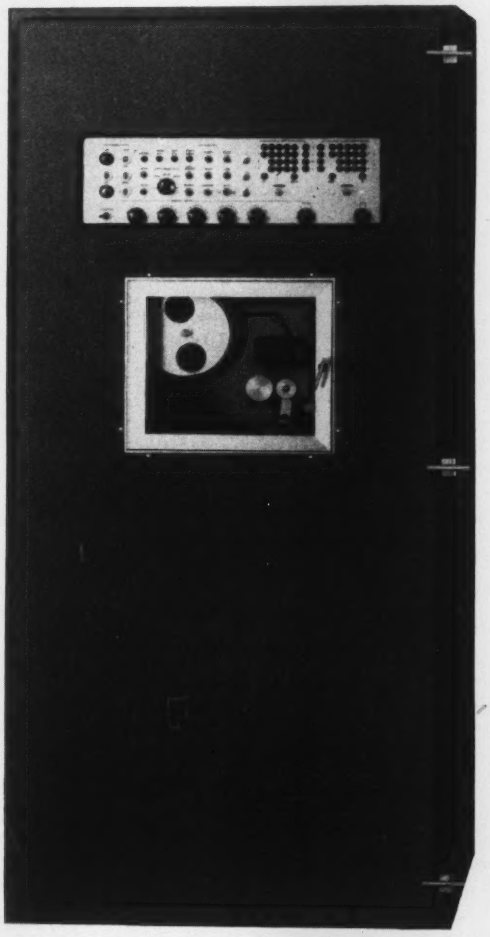


Longer tape life with extra accuracy: Sensitive photo-electric tape reader eliminates deformation of tape holes; reduces possibility of tape wear and tearing. No pneumatic or hydraulic connections required for tape reading operation.

Easier set-up and program checking: Display lights on control panel indicate coordinate dimensions enabling operator to verify the accuracy of programming quickly and easily. Control panel human-engineered for maximum efficiency in operation.



Fast, accurate positioning; easy mechanical maintenance: Drive package positions table at 180 inches per minute; repeatable accuracy: ±0.0002", non-cumulative. Use of standard industrial electric motors and clutches assures quick repairs.



Creating a new world with ELECTRONICS

HUGHES

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INDUSTRIAL SYSTEMS DIVISION

For full information on the application of the *all-electronic* Hughes Numerical Control to your particular problems, please write or wire: HUGHES, Industrial Systems Division, P.O. Box 90904, Airport Station, Los Angeles 45, California. For export information, write: Hughes International, Culver City, California.

Check the exclusive features of the Hughes Numerical Control! See it in operation in Booth 2117 at the ASTE Show, Detroit, April 21-28.

Count Control
COMPONENTS
FOR AUTOMATING INDUSTRIAL PROCESSES

featuring
adjustable count
automatic reset
10 ampere switches

model HZ4
MICROFLEX RESET COUNTER

Use to control an operation for a preset number of counts. Has spring reset to "0." Dial ranges 19, 400 and 1,000 counts.

Ask for bulletin 720.

model HZ200
ADD-SUBTRACT COUNTER

Add-Subtract counter — operates from ADD pulses which trip switch at maximum limit—and SUBTRACT pulses which trip switch at "0" limit.

Ask for bulletin 740.

model MT
STEP SWITCH

Use for sequence control from pulses—19 contacts—60 cycle coil-break out cam lugs.

Ask for bulletin 780.

model HZ6
MICROFLEX REVOLUTION COUNTER

Use to control an operation as a function of mechanical movement—drive shaft can be mechanically connected to machine, spindle, conveyor, etc.

Ask for bulletin 730.

model HM
MULTIFLEX *(Multiple Circuit)* TIMER

Use for sequence control of 1 to 7 circuits. With shaft drive for mechanical connection to an external drive mechanism.

Ask for bulletin 130.

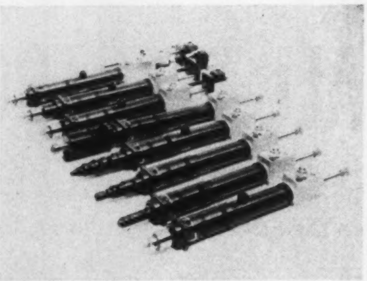
Write us regarding your count problem. Services of Sales Engineers in 25 district offices are available without obligation. Address Dept. A-460.

A DIVISION OF THE GAMEWELL COMPANY

EAGLE SIGNAL COMPANY
MOLINE, ILLINOIS

MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS

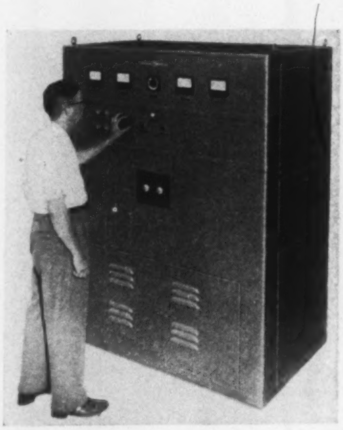
Circle 721 on Page 19



Air Tools

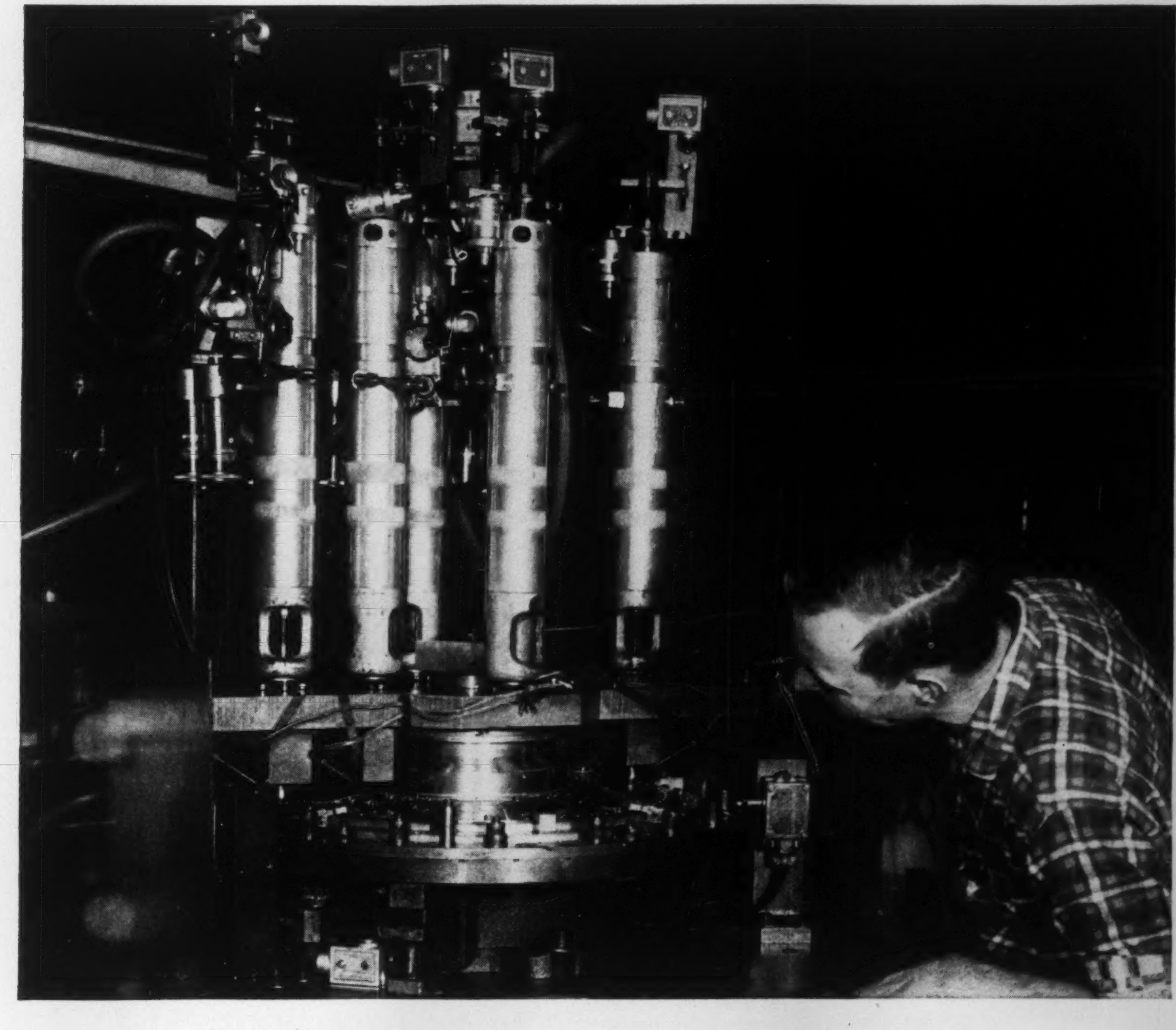
Line of air tools is applicable in drilling, tapping, fastening, grinding, reaming, counterboring, and wire brushing operations. The tools can be operated singly or in groups following any desired sequence with controls matched to the desired degree of automation. The tools provide rotary motion and linear motion, moving from a fixed retracted position to a precise work spot. Length of the stroke can be adjusted to micrometer accuracy over a zero to 2-inch range by rotating a graduated external sleeve, then locking it in place. Two series are available. The 21K Series is retracted by a spring return system, and the 21L Series is retracted by a double-acting air cylinder. **Buckeye Tools Corp.**, 5003 Springboro Pike, Dayton 1, Ohio.

Circle 447 on Page 19



Induction Heating Unit

High-speed induction heating unit can be used for selective hardening, tempering, and annealing of tool steel parts. It can also be adapted to other heating and bonding operations. Both the heater



“Airfeedrills”® cut drilling time 88% on jet aircraft part

Time required for drilling 104 holes in a bearing support for a jet aircraft compressor was cut 88% when the manufacturer switched from other methods to five Gardner-Denver "Airfeedrills."

Three bolt circles were drilled at two different levels; 72, 8 and 24 holes were drilled in bolt circles 18 7/8", 10.2" and 8.5" respectively. All holes in the material—AMS-6415—were drilled to close Air Force tolerances. A 36-station index table, plus automatic "Airfeedrill" controls, automated the entire operation.

VERSATILITY AND INTERCHANGEABILITY

This is just one more example of the versatility and interchangeability of Gardner-Denver "Airfeedrills." They're easily adapted to almost any drilling setup. You mount them as a drilling unit of 2, 20 or more spindles for automatic hole processing. Use one as a stationary drill mounted on an inexpensive fixture. As a portable drill, "Airfeedrill" hangs by its nose to a jig for precision drilling.

See for yourself how quickly and inexpensively you can automate *your* drilling operations . . . see your Gardner-Denver representative or write for Bulletin 92-1 on "Airfeedrill" specifications and applications.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Circle 722 on Page 19

DESIGN CONSIDERATIONS

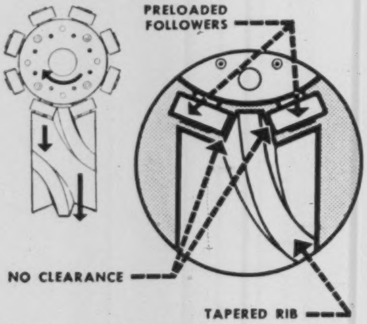
Inherent Precision of Indexing Shortens Machine Cycle...Increases "Operations" Time

The inherent characteristics of indexing mechanisms enhance or detract from the designer's opportunities to attain full utilization of the modern methods that contribute so much to production economy. Operations can be performed only as fast as the rotary or in-line transfer of work pieces can be achieved without sacrificing necessary accuracy. With many indexing devices, production rate or productive work time must be infringed upon to allow slower, more accurate indexing.

Of three principal indexing mechanisms, only one offers an optimum combination of transfer accuracy **and** speed **plus** long, maintenance-free life.

FERGUSON DRIVE

FIG. 1 FERGUSON DRIVE



Continuously rotating cam includes a tapered rib along which two preloaded bearing followers roll with no clearance between them and the hub. Indexing occurs when a curved portion of the rib causes the hub and followers to move one increment. While in the "work" or dwell position a straight portion of the rib positively locks the hub with **zero backlash.**

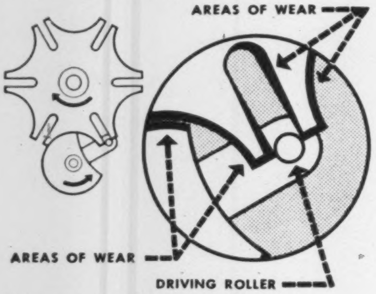
Preloading the followers results in an inherent or "built-in" precision of indexing within .001" without auxiliary locking or locating methods . . . at speed up to 2,000 indexes a minute . . . and for a minimum of 8,000 hours without maintenance!

If maximum accuracy is a necessity, worn followers may be replaced to renew life of the Drive for another 8,000 hours. Cams, subject to slight rolling friction only, have indeterminate life.

GENEVA DRIVE

Indexing occurs when a driving roller crashes into the slotted wheel. Clearance in the slot, to allow passage of the roller, causes backlash and, therefore, inaccuracy of index. Impact loading causes the slots to wear quickly and the inaccuracy becomes progressively more severe. The addition of shot pins or other types of auxiliary locating methods add to the cost, complicate the design and consume what might otherwise be productive worktime. Operating speeds must be held down to prolong the life of the geneva drive and contain the dynamic forces generated by the inherent backlash.

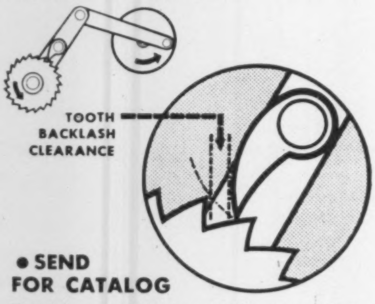
FIG. 2 GENEVA DRIVE



RATCHET & CRANK

Friction braking employed to stop the wheel after indexing allows over-travel which results in inaccuracy of index. Use of positive means causes an instantaneous stop with tremendous impact and rebound action. Neither method is satisfactory from the standpoint of low maintenance requirements or controlled dynamic conditions. Tooth clearance backlash also contributes to the extreme inherent vibratory forces. Sustained high speed production is virtually impossible.

FIG. 3 RATCHET & CRANK



• SEND FOR CATALOG

Precision at high speeds is but one of the inherent advantages of the Ferguson Drive. Others are explained in our easy-to-use catalog. Write for your copy of new Catalog No. 160 or visit our booth No. 1461, Detroit A.S.T.E. Show and see HIGH SPEED PRECISION INDEXING IN ACTION.

Ferguson Machine Corporation
7818 Maplewood Industrial Ct.
St. Louis 17, Mo.

Circle 723 on Page 19

stations (there are up to 4 stations) and the power generator are incorporated in a single unit. Controls and instruments are mounted on a convenient, eye-level panel, with the heater stations. The unit is available with 5, 10, 20, 30, and 60 kw capacities, and with 3-phase, 60-cycle power supply. **C. I. Hayes Inc.,** Wellington Ave., Cranston 10, R. I.

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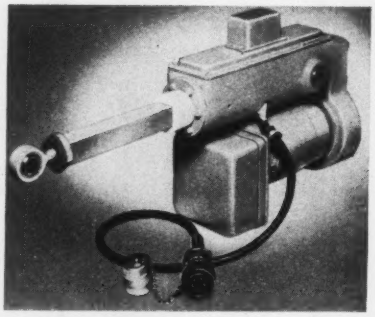

Linear Actuator

Electrically-driven linear actuator can be used wherever open-loop positioning is required. It can move three-quarters of a ton and can hold a ton-and-a-half. The stroke of Model 499B is continuously adjustable from 4.25 to 5.25 inches. It is powered by a single-phase, 115 v, 60 cycle motor capable of developing 0.14 hp at 5000 rpm. Another style actuator, Model 499B-1 is furnished with a stroke of from 2.75 to 3.75 inches. **Lear Inc.,** P. O. Box 688, Grand Rapids 2, Mich.

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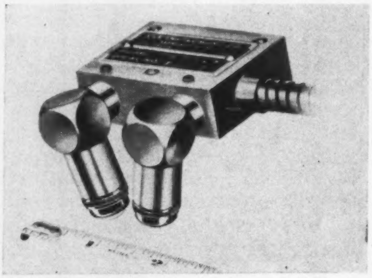
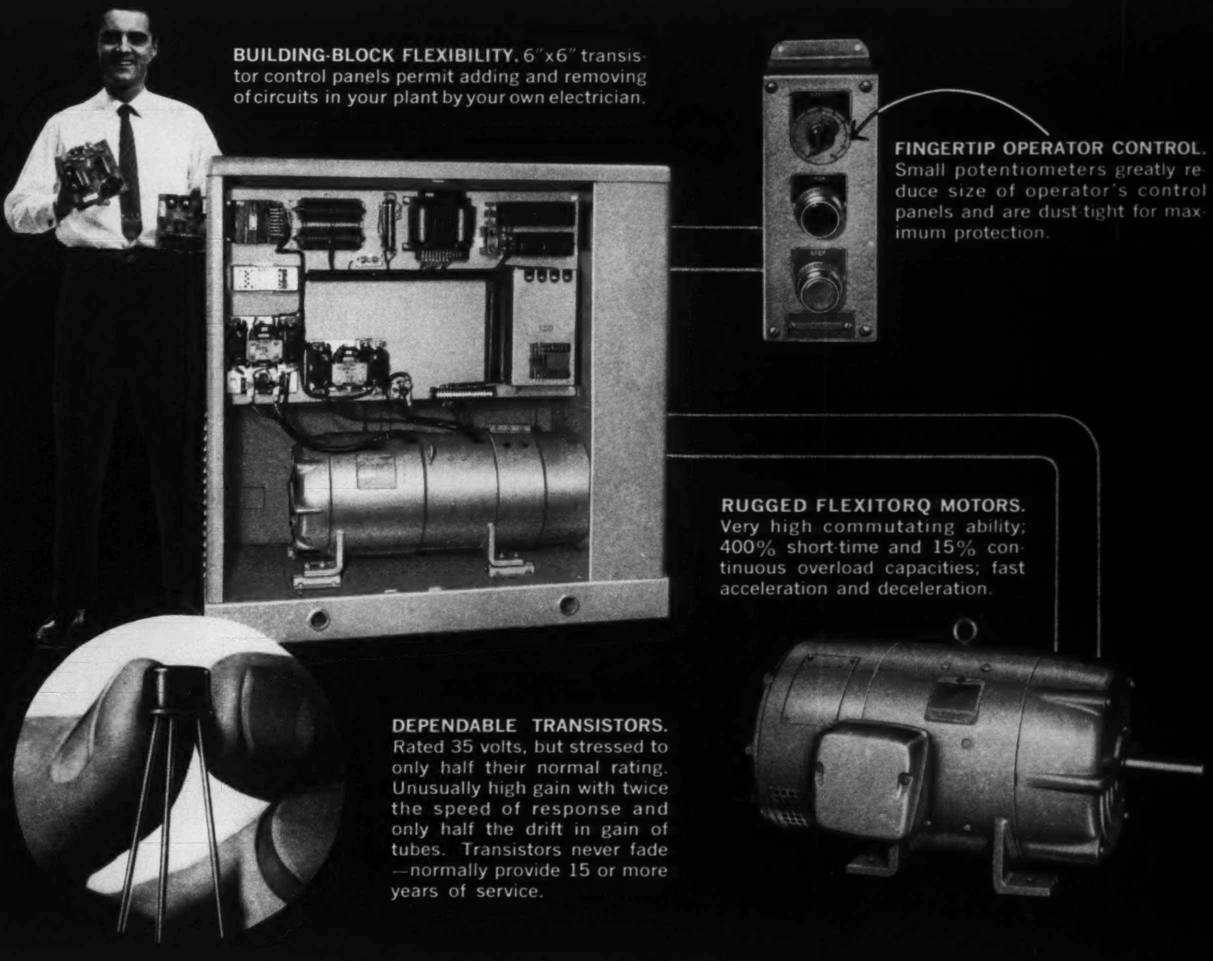


Reflector Type Pickups

Reflector type photoelectric relay units can be used with various company controls and counters for in-



BUILDING-BLOCK FLEXIBILITY. 6″x6″ transistor control panels permit adding and removing of circuits in your plant by your own electrician.

FINGERTIP OPERATOR CONTROL. Small potentiometers greatly reduce size of operator's control panels and are dust-tight for maximum protection.

RUGGED FLEXITORQ MOTORS. Very high commutating ability; 400% short-time and 15% continuous overload capacities; fast acceleration and deceleration.

DEPENDABLE TRANSISTORS. Rated 35 volts, but stressed to only half their normal rating. Unusually high gain with twice the speed of response and only half the drift in gain of tubes. Transistors never fade—normally provide 15 or more years of service.

The New LOUIS ALLIS Select-A-Spede® Drive —First with field-proved All-Transistor Control

a high-gain, high performance d-c drive with unmatched flexibility and low upkeep

Here's a superior adjustable speed drive with simplified transistor-magnetic amplifier control. It's the easiest drive to set up and operate. A twist of the dial gives you stepless speed adjustment from zero to full speed in either direction. Each adjustment is independent, thus sparing you the need for compensating adjustments of inter-related settings. You get more consistent day to day operation because transistors — *unlike tubes* — are highly dependable.

The new Select-A-Spede defies obsolescence. To add functions you simply have your electrician install any of 13 "building-block" control circuits as your conditions require. These circuits come on inexpensive 6″ x 6″ panels ready for installation and are immediately available from Louis Allis stock. Thus a rebuilding or adaptation job that, on former equipment, cost thousands of dollars — excluding downtime — can now be done at a fraction of the cost and time *right in your own plant!* High quality transistors, field proven in missiles and other advanced electronic equipment, assure you of a high degree of dependability with a life expectancy of 15 or more years. Printed low-voltage transistor circuits are virtually trouble-free and can be quickly and easily replaced from low-cost stock.

Further savings are provided by the new Louis Allis Flexitorq® drive motors through vastly improved commutation, low brush wear, and their ability to safely withstand momentary overloads of 400% of normal horsepower rating.

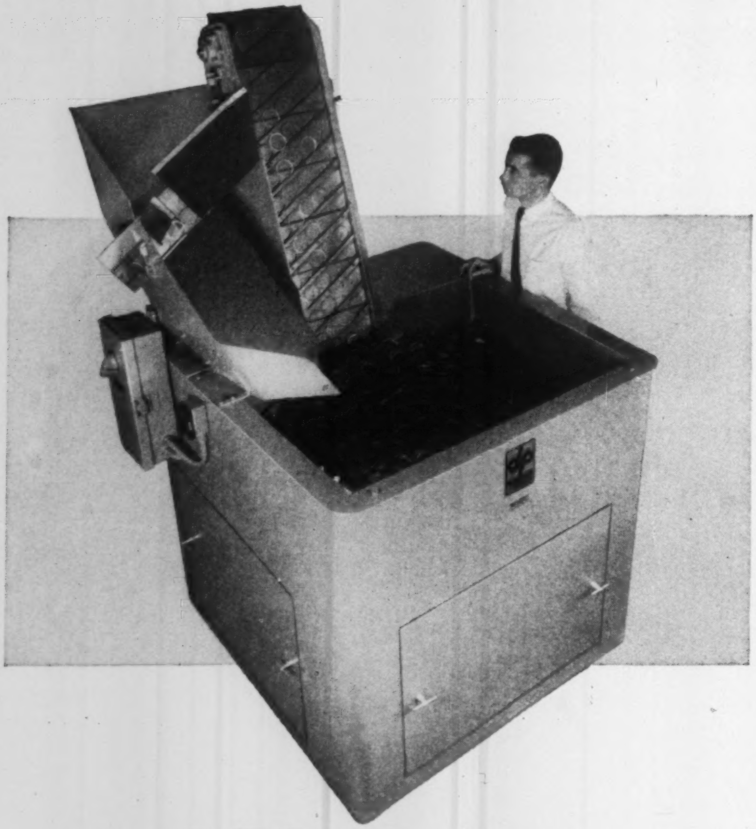
Select-A-Spede sizes from 5 to 400 hp, speed ranges up to 20:1. Contact any one of the 60 Louis Allis District Offices for information and application assistance. Or write for bulletin 2001 to The Louis Allis Co., 463 E. Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 724 on Page 19

SA-202



DPS elevating feeders

How DPS elevating feeders elevate, orient, feed your parts to cut production costs

New elevating feeders from Detroit Power Screwdriver Company—
- Eliminate hand feeding
- Permit high-speed feeding and orienting
- Discharge parts at height to suit your requirements
- Offer adequate holding capacity

The output of hand-fed production machinery soars with DPS elevating feeders. Parts of almost any size, shape and material can be fed quickly, gently, in a continuous flow to other machinery for processing and assembly.

Three standard sizes available: 6, 12 and 20 cu. ft. holding capacities. Larger or smaller units can be fabricated to meet special requirements.

- NEW BULLETIN
. . . has complete information on new DPS elevating feeders. Mail the coupon today!

15,333

A Subsidiary of
Link-Belt Company

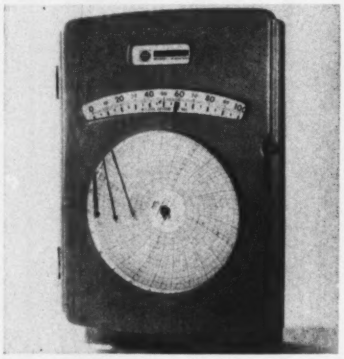
DETROIT POWER SCREWDRIVER COMPANY
2811 W. Fort St., Detroit 16, Michigan
Send new Elevating Feeder Folder 2812.

NAME__________
FIRM__________
ADDRESS__________

Circle 725 on Page 19

specting and sorting. The position of the light source and photo unit is adjustable as to the angle and reflection of spot distance. Controls for adjusting the light sensitivity and the photo sensitivity permit the relay to be triggered at any desired threshold of reflected light. In conjunction with the proper amplifier, the pickups can be used for extremely close registration applications. **Photomation Inc.**, 96 S. Washington Ave., Bergenfield, N. J.

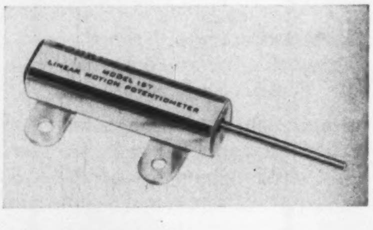
Circle 450 on Page 19



Recorder-Receiver

Totalizer, indicator, recorder unit is applicable for telemetering flow, pressure, temperature, level, position, rpm, and electrical quantities. Features of the unit include 2, 4, 8, 15, and 60-second time-cycles, up to 16 control switches for alarm and control functions, and multiple pen arrangements. The instrument has a capillary-fed ink supply and a swing-out panel for easy access. **B-I-F Industries Inc.**, 345 Harris Ave., Providence 1, R. I.

Circle 451 on Page 19

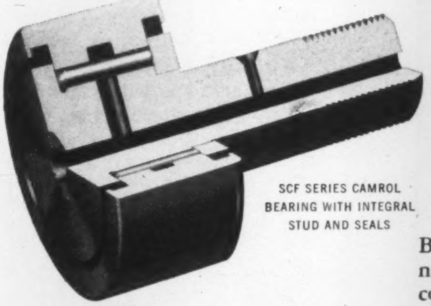


Potentiometer

Miniature, wire wound potentiometer features a self-aligning shaft that permits measurement of linear

AUTOMATION TIPS
by McGill

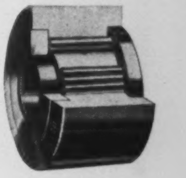
Specify CAMROL® bearings with assurance of improved performance—dependable long life


SCF SERIES CAMROL BEARING WITH INTEGRAL STUD AND SEALS

McGill CAMROL bearings are proven with over 25 years' application experience and gradual product improvement. You can rely on their designed-in ability to accept the intermittent shock and heavy load of cam action, guide and support roller applications.

Built for stock in roller diameters from 1/2" to 4", CAMROL bearings eliminate the procurement and assembly of bolts, rollers, end washers and similar components of improvised followers.

The CF series (with stud) and the CYR series (for shaft mounting) are available also with integral seals for protection against contamination. Lubricant is retained to avoid frequent relubrication. The following are typical of millions of CAMROL bearings serving industry. Ask McGill engineering to held with your automation problems.

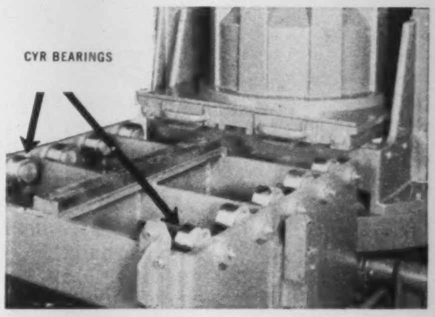

CYR SERIES CAMROL BEARING FOR SHAFT OR YOKE MOUNTING

CAMROL CF bearings insure smooth and accurate indexing of welding carriage for ACRO WELDER

ACRO WELDER MANUFACTURING COMPANY uses McGILL bearings in many applications to reduce friction, minimize wear associated with plain bearings and assure accuracy in their welding machines.

In the special purpose welder shown, sealed CAMROL bearings support and guide the linear indexing carriage with assured accuracy and reduction of friction. Integral seals protect bearing life and cut re-lubrication needs.

The 300 pound carriage indexes at a speed of 200 IPM through a 5" distance and is then slowed to a speed of 100 IPM for a 1" weld length, accomplishing 476 welds to join 17 bars to 14 cups. CAMROL bearings help improve machine performance that cuts welding time from five to 1/3 of a man-hour per assembly.



CAMROL CYR bearings are trouble-free and accurate in NATCO machines

The photo shows CAMROL CYR Series which support and convey jig-type fixtures into NATIONAL AUTOMATIC TOOL COMPANY multi-spindle machines which drill and ream stainless steel weldments for jet engines.

Twenty-four CYR bearings reduce friction and provide smooth trouble-free and accurate operation in these machines.

NATIONAL AUTOMATIC TOOL COMPANY reports that performance of McGill CAMROL bearings has been excellent and that they have "never had a service report as to the malfunction of a McGill bearing."

engineered electrical products

McGILL®

precision needle roller bearings

Send for Free Bearing Catalog No. 52-A for complete data.

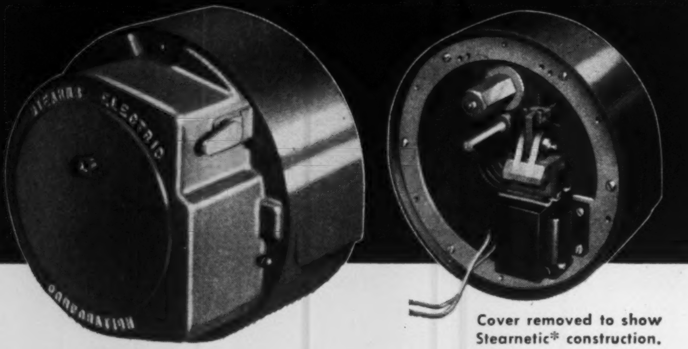
MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING COMPANY, INC.
BEARING DIVISION, 401 N. LAFAYETTE STREET, VALPARAISO, INDIANA

Circle 726 on Page 19

...announcing the NEW "42,000 Series" Stearnetic* DISC BRAKES

(the choice of leading electric motor manufacturers)



Cover removed to show Stearnetic* construction.

*Stearnetic — Stearns exclusive unitized, electro-magnetic operating mechanism.

...up to 33% shorter
permits more compact, space-saving installations — less overhang . . . as much as 3 in. shorter than competitive units — up to 4½ in. shorter than previous high-torque Stearns brakes.

...up to 50% lighter
easier to handle and install — cost less to ship . . . up to 50% lighter than competitive units.

- ★ Max. Torque Range — 125 to 575 lb ft.
- ★ AC or DC models—all single phase — only two lead wires for fast, simple installation.
- ★ Standard motor or floor mountings . . . two styles of enclosures.
- ★ Exclusive Stearns "Visi-Wear" indicator.
- ★ Single point release — single solenoid design.
- ★ For standard or straight-thru shafts.
- ★ Exclusive Stearns one-point adjustment for wear.
- ★ A screwdriver is your complete maintenance tool kit.
- ★ Wide-range torque variation for stops that match the application.
- ★ Smooth, clean, modern exterior design to match modern motors — no protruding parts to catch clothing — easy to clean.

Send for Special Information Sheet No. 2Q

BRAKES STEARNS ELECTRIC MILWAUKEE CLUTCHES

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN

Circle 727 on Page 19

displacement even when perfect alignment with an actuating member is impossible or where high vibration conditions are encountered. The floating shaft permits free lateral movement of an actuator without side-load effect on the instrument. Travel ranges are ½, 1, and 1⅜-inch; power rating is 1.5 w per inch at 40 C. Operating temperature range of Model 157 is −65 to 374 F. It will operate reliably at 40 g up to 2000 cps with error less than ½ per cent. **Bourns Inc.,** 6135 Magnolia Ave., Riverside, Calif.

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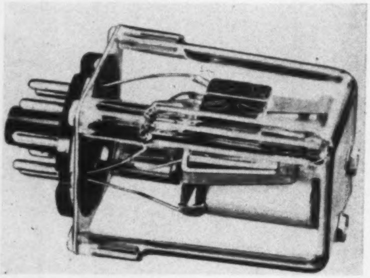

Plug-In Relay

Miniature plug-in relay features a transparent cover which insulates the unit from electrical interference with other components. The cover also acts as a protection against tampering, dust, and iron filings. The relay, designated Class 33, can be furnished for dc operation with contact combinations to 3 pdt. The enclosure is available with 8 or 12-pin octal style plug which mates with Amphenol socket 77MIP-8, 12, or equivalent. **Magnecraft Electric Co.,** 3354D W. Grand Ave., Chicago 51, Ill.

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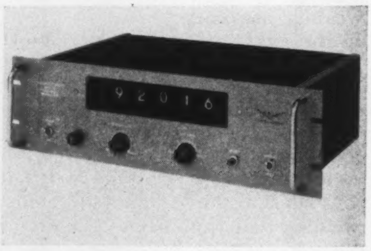

Frequency Flow Counter

Instrument features in-line Nixie readout, can read directly cps, gpm,

Fourth Conference on Manufacturing Automation

TO BE HELD AT

Purdue University, Lafayette, Indiana
April 11, 12, and 13, 1960

For production executives, manufacturing engineers, and administrative managers who plan, design, and install automated systems for industry.

As in past conferences, informal discussion groups will be set up where automation authorities will be available to answer specific questions and exchange experiences. Exhibits of automation components and systems have also been arranged.

Cosponsored by

MANUFACTURING ENGINEERING COUNCIL
PURDUE UNIVERSITY
School of Mechanical Engineering
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and
AUTOMATION

FEE

Fee for the Third Conference on Manufacturing Automation is $85 which will include the Banquet, the noon Luncheons, and a copy of the Transactions.

LODGING

Rooms are available at the Union Club on the campus at $4 and $6 single, $6 double, and $7 to $9 twin. Room reservations may be made with the Union Club by the form supplied. Accommodations are also available at the Fowler Hotel in Lafayette (city bus to campus) from $3.50. Write direct. For those driving, reservations may be made at the Morris-Bryant Motel, Cedar Crest Motel, or Green Acres Motor Court (2-4 miles north on U. S. 52). For additional information, write K. E. Glancy, Div. of Adult Education, Purdue University, Lafayette, Ind.

CONFERENCE TOPICS AND SPEAKERS

Engineering Costs—Who Pays? (Automation Panel)

BUYERS K. C. BUTTERFIELD, Staff Master Mechanic, Chrysler Corp.
W. W. KUYPER, Manager, Manufacturing Engineering, Large Steam-Turbine Generator Dept., General Electric Co.
R. L. SCHOENBERGER, Manager, Production Engineering Dept., R. R. Donnelley & Sons Co.
W. A. STADTLER, Director of Manufacturing Research, I.B.M. Corp.

SELLERS J. R. BAREFOOT, President, Federal Machine & Welder Co.
LEO GAJDA, Vice President, Snyder Corp.
E. McFERREN, Vice President-Sales, Giddings & Lewis Machine Tool Co.
W. K. STOKES, Vice President-Sales, Alvey Ferguson Co.

Manufacturing Research and Automation
T. R. BUNNELL, Manager of Manufacturing Services, Semiconductor Div., Sylvania Electric Products Inc.

Getting a Grip on Costs and Payoff
K. H. MEYER, Manager, Mfg. Services, Reliance Electric & Engineering Co.

Organizing to Reduce Costs through Automation
C. D. EVANS, Ass't. Manager, Mfg. Research, International Harvester Co.

Process Analysis and Machine Procurement
H. A. LEONE, Manager, Headquarters Mfg. Lab., Westinghouse Electric Corp.

Automating Assembly
C. H. STANDISH, President, Designers for Industry Inc.

Integrating the Packaging Operation
WILLIAM WOOD, President, Processes Research Inc.

Techniques for Parts Handling
R. H. BONNER, Application Engr., Industrial & Machine Tool Operations, Radio Corp. of America

Dispensing Problem Materials in Process
L. E. HARPER, President, Omega Machine Co. Div., B-I-F Industries Inc.

Mechanization for Distribution
E. J. HARDY, Ass't. Supt., Engineering Equipment Development, Western Electric Co.

Temperature Controls
H. G. PAYNE, Manager, Measurement Group Sales Product Div., Foxboro Co.

Using Relay Control Effectively
ZEKE SMITH, Vice President & Tech. Dir., Potter & Brumfield Div., American Machine & Foundry Co.

Doing the Job with Photoelectrics
J. J. LAREW, Product Engr., Specialty Control Dept., General Electric Co.

LUNCHEON AND BANQUET TOPICS AND SPEAKERS

Pioneering in Automation
W. C. LEONE, Vice Pres. & Gen'l. Mgr., Electronics Div., Rheem Mfg. Co.

You and the MEC
F. I. ELLIN, Chief Production Engr., Ohmite Mfg. Co.

A Look Into Tomorrow
JOSEPH HARRINGTON JR., Head, Mechanical Engineering Section, Arthur D. Little Inc.

Don't Give Up
ROBERT MOORE, President, Moore Equipment Co.

The Inevitability of Automation
H. A. STRICKLAND JR., Vice President & Gen'l. Mgr., Industrial Electronics Div., General Electric Co.

Mail to: AUTOMATION CONFERENCE, Comptroller's Office (Conferences), Purdue University.

ROOM RESERVATION

Please reserve in the Union Club the accommodations checked:

Nights: April 11 ☐ April 12 ☐ April 13 ☐

Single Bed—Bath ☐ Twin Beds—Bath ☐

If necessary, will share twin-bed with another member ☐

Room will be shared by ____________________

Please send confirmation:

Name ____________________
Company ____________________
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CONFERENCE REGISTRATION

The following persons plan to attend the AUTOMATION CONFERENCE, April 11, 12, and 13, 1960 (name and title, please):

Name ____________________
Title ____________________
Name ____________________
Title ____________________

$________is enclosed for the registrations checked at $85 each. (Make checks payable to Purdue University.)

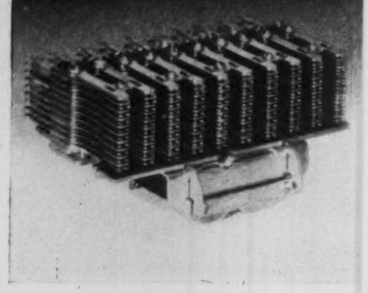
☐ Fees will be paid at registration time.

Name ____________________
Company ____________________
Address ____________________

Circle 728 on Page 19

STROMBERG-CARLSON

"BB" SERIES RELAYS



For your automation ...computing...control circuit applications...

"TELEPHONE QUALITY" at an ordinary price

To meet your needs for precision and durability in automation, computing and control circuitry, this relay provides *telephone quality* at an ordinary price.

The "BB" Series Relay accommodates up to 100 Form A spring combinations. It incorporates such important advantages as twin contacts, knife-edge pivot and special frame-armature construction. Like all Stromberg-Carlson relays, it is built to operate under extreme ranges of temperature and humidity. *Prompt delivery is available on all orders.*

For full information write to Telecommunication Industrial Sales, 111 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

Circle 729 on Page 19

rpm, or any physical variable that can be converted to a proportional frequency. The number of electrical events counted during a precise, selected gating interval of 1/10, 1, or 10 seconds is held during an adjustable display time or held indefinitely until manually reset. Model 720 is available with a choice of 3 to 6 decades, four time base modules, a remote readout indicator operable at distances to 100 feet, a high sensitivity preamplifier providing 10 mv sensitivity, provisions for photocell input, accessory power output, and external reset. Dual - channel trigger amplifier-shaper modules are available for time interval measurements. **Erie-Pacific, Div., Erie Resistor Corp.**, 12932 S. Weber Way, Hawthorne, Calif.

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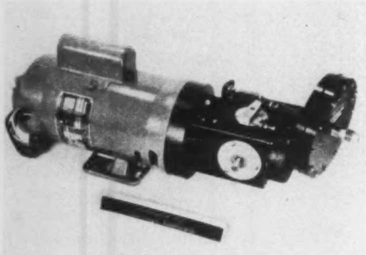

Variable Speed Drive

Variable speed drive features a diaphragm for vacuum or pressure control. The drive is applicable for process control applications or for conversion from pneumatic to mechanical systems. Speed control over the range from full speed forward to full speed reverse is achieved with a pressure range of approximately 0 to 10 inches of water. The drive can also be furnished with a smaller diaphragm for higher working pressures. Designated Servotran, the unit is available in sizes ranging from the subminiature 1/1000 to 1/100 hp range up to 1/10 hp. Other styles available include a drive with a push rod arrangement for direct mechanical control, and a solenoid for remote three-speed control. **Humphrey Products Div., Humphrey Inc.**, 2805 Canon St., San Diego 6, Calif.

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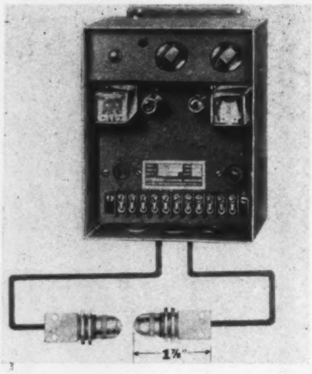

Photoelectric Control

Miniature photoelectric control is applicable for counting, sorting, inspecting, liquid level and bin level control, cut-off control, loop regulation, and precision filling operations. Unit consists of a light source, photocell, and transistorized amplifier (tube amplifiers are also available), which can be interconnected by plug-in terminals and receptacles. Operation is by beam interruption or by reflection. The operating range of standard unit is up to 20 feet, with speeds as high as 1000 sensings per minute. The unit is provided with clearance holes for flush mounting, threaded bushings for panel mounting, or swivel base and ball joint for ease of alignment. **Standard Instrument Corp.**, 657 Broadway, New York 12, N. Y.

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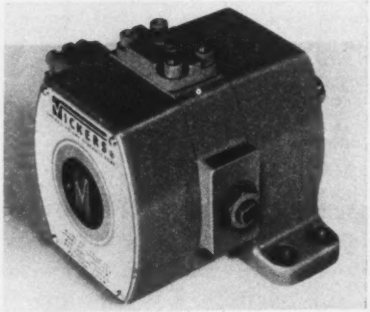

Variable Vane Pump

Vane type, variable volume hydraulic pump can be used in circuits that require pump delivery to vary according to system needs while maintaining preselected adjustable pressure. An integral pressure compensator can be set for operation at 200 to 500 psi. Sharp cut-off characteristics enable the pump to deliver nearly full volume up to the compensator setting even at low operating presures. Pump, designed for operation with 1800 rpm electric motors, is available for flange, foot, or gasket mounting. **Vickers Inc., Div., Sperry Rand Corp.,** 1400 Oakman Blvd., Detroit 32, Mich.

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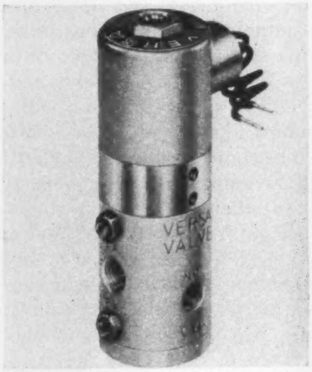


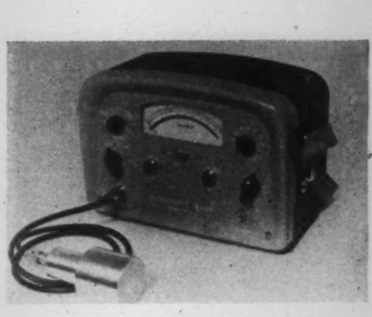
Solenoid Valve

Designed for pneumatic or hydraulic fluid power applications in the 40 to 300 psi range, 4-way solenoid actuated valve has a full 3/16-inch diameter flow area. Over 100 different variations in both side ported and manifold models are available. Included in the range of available options are: Hydraulic adapters, integral junction boxes, manual over-ride, and threaded exhaust blocks. All parts in the unit are interchangeable and the electrical components can be replaced without disturbing the valve or connections. **Versa Products Co. Inc.,** 150 Coolidge Ave., Englewood, N. J.

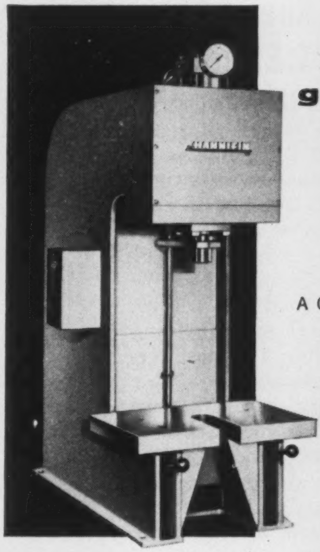
Circle 458 on Page 19

Portable Thickness Gage

Instrument is capable of measuring thickness and inspecting corrosion in pipes, storage vessels, and hull plates. The portable unit can be strapped on an operator's back and carried into confined areas. Measurements are read on a directly calibrated meter and alarm lamps are provided to set thickness limits. The pulse-echo method of detecting changes in metal thickness is used in the gage. This technique measures thickness where the surfaces are not parallel, or if they are pitted or rough. A dial compensates for the velocity of sound so the meter will directly read the thickness of materials such as aluminum, steel, brass, copper, lead, lucite, nylon, polystyrene, and liquids. Once the operator has adjusted the material dial for the metal being inspected, the instrument reads directly in inches. Accuracy in reading is 1 per cent of full scale. **Sperry Products Inc.,** Danbury, Conn.



Circle 459 on Page 19



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Circle 730 on Page 19

New V&O Ultra High Speed Press Scheduled for A.S.T.E. Debut

We are building what we think is the industry's fastest power press. We hope to have it ready for introduction at the A.S.T.E. Show. As of this writing, about two months before show time, it looks as if we will make it. But just in case we do not, we want you know it was not for lack of trying.

This new V & O press is truly high speed. We cannot tell you now what the maximum will be, but we can say it will be higher than anything envisioned by all except, possibly, the most forward-looking production executives.

To prove that it is a reality, here are some facts (which we hope will whet your desire to get more): it is a horizontal unit, incorporating a vertical crankshaft with flywheel, clutch and variable speed drive in the base of the machine for a low center of gravity; capacity is 25 tons; stroke is ¾"; it is equipped with double roll feed for 6" wide stock 4" max. length of feed and can be adapted for strip feeding from a magazine.

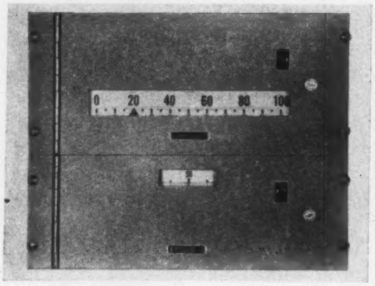
As a supporting attraction, we will have an automated unit for secondary operations. It will comprise a No. 2 V & O inclinable press equipped with an automatic press feed (V & O Feed-O-Matic) which is fed, in turn, by a vibratory hopper. This unit alone merits your consideration as a demonstration of how we can help you achieve automation on a practical basis, using available equipment.

You are cordially invited to drop by and see our latest development if it is built in time. Get the complete facts for a near-future look if it isn't on the show floor. The booth number is 1944.

Emhart Manufacturing Co.
Hudson Div., Hudson, N.Y.
Formerly V & O Press Div.

EMHART

Circle 731 on Page 19



Servomechanisms

Rack-mounting servomechanisms are suitable for applications in computing systems and all types of control systems. They are mounted in hinged swinging panels, will fit standard 19-inch relay racks. Model 694 (above in photo) uses an 11-inch Dynamaster scale. This unit is used when the operator wants to see the entire scale range. Retransmitting slidewires, analog-to-digital encoders, and alarm contacts can be mounted on the slidewire balancing shaft. Model 692 (below in photo) has a drum type scale, is mounted in a panel 7 inches high. The slidewire balancing shaft provides for mounting a retransmitting slidewire or alarm contacts. It can be mounted in a higher panel to accommodate encoders or additional retransmitting slidewires. **Bristol Co.,** Waterbury 20, Conn.

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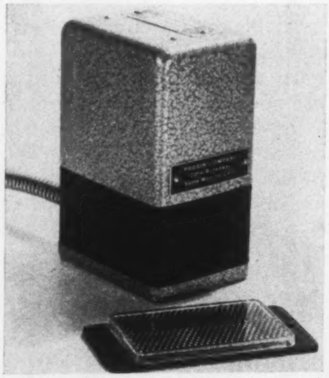

Photoelectric Control

Device is available with focused and parallel beams for operating as close as 1-inch or as far as 80 ft from the object. Objects smaller than 0.05-inch in diameter can be detected. The light source, photocell, and transistorized amplifier are combined in a single package. A single lens serves for the exit and return of the light. A special mirror, consisting of many corner reflector elements, returns the beam of light directly back to the light source despite misalignments in excess of 15 degrees. The unit is insensitive to ambient light and its single lens system simplifies installation problems. **Presin Co.,** 2014 Broadway, Santa Monica, Calif.

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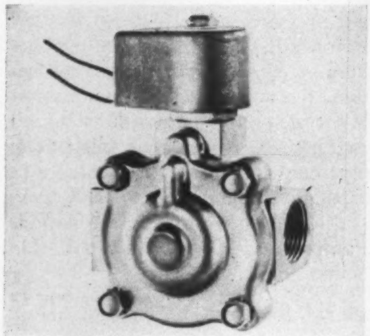


Solenoid Valve

Two-way solenoid valve can provide automatic control of the flow of liquids and gases in pipe lines for heating and refrigerating equipment, lubricating equipment, spraying equipment, machine tools, sprinkler systems, and hydraulic elevators. It can handle air, gas, water, light oil, and other noncorrosive liquids or gases at pressures from 5 to 125 psi. The 1-inch valve, available for either normally closed or normally opened operation, can be mounted in any position. The self-contained internal pilot operated unit has forged brass bodies and bonnets with three moving parts—a Buna N diaphragm, stainless steel diaphragm spring, and stainless steel solenoid core. **Automatic Switch Co.,** Florham Park, N. J.

Circle 462 on Page 19

Heavy-Duty Process Pump

Device is capable of handling fluids with fibrous, granular, or other type solids in suspension

Typical Control Functions solved by AIR CIRCUITRY

WESTINGHOUSE
"H" CONTROLAIR® VALVES

Air control valves are not limited to directional control in Westinghouse Air Brake Company's complete line of Air Circuitry components. Pressure control, in addition to directional control, is obtained with the versatile "H" CONTROLAIR Valves. The position of its operator—lever, pedal, cam or knob—determines the air pressure delivered by the valve. Changing operator positions changes delivery pressure.

Precise pressure graduations may be made in one or two outlets to provide exacting remote control of variable force and positioning applications. Besides those functions illustrated a wide variety of pressure and directional control combinations is available. For details, ask for Catalog D4-65.00.

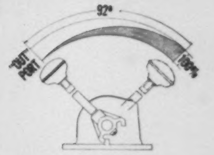
Applications for "H" CONTROLAIR Valves are limitless. They operate:

Throttles
Clutches
Brakes
Clamps
Gates
Rolling Mills
Presses
Shears
Conveyors
Dredges
Marine Propulsion Engines
Construction Equipment
Oil Drilling Rigs
Production Tools
Cranes and Shovels

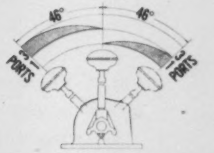
and many other kinds of equipment and machines. In fact, "H" CONTROLAIR Valves are used wherever it is necessary, or preferable, to have instant and convenient control of the flow of air into a pneumatic circuit and of the pressure build up of air in that circuit.

What is AIR CIRCUITRY?

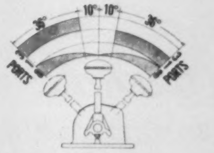
This is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise AIR CIRCUITRY is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.



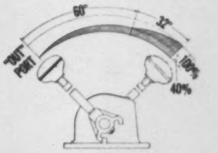
1. SINGLE LINE PRESSURE CONTROL—Pressure regulation in a single line is obtained through the H-2 CONTROLAIR Valve. This lever-operated, 3-way, pressure regulating valve increases, decreases or maintains outlet pressure according to its lever position. Several types of lever return or holding functions are available.



2. DIRECTIONAL AND PRESSURE CONTROL — The HC-2 CONTROLAIR Valve provides pressure graduation to either of two outlets. This lever-operated 4-way, pressure regulating directional valve consists of two 3-way directional valves and a 3-way pressure regulating portion. Lever movement either side of its "Neutral" position selects the outlet to be activated. Further lever movement in the same direction controls the pressure of the air delivered to that line.



3. DIRECTIONAL AND PRESSURE CONTROL — Pressure regulation plus full supply pressure directional control is possible with the HD-2 CONTROLAIR Valve. This lever-operated valve consists of two 3-way directional valves and a 3-way pressure regulating position. Each unit has its own outlet. Lever movement either side of "Neutral" provides full inlet pressure to a chosen outlet plus graduated pressure to a third outlet.



4. TWO RATE PRESSURE CONTROL—The first 60° of lever movement from the "Off" position provides an increase in delivery pressure from 0 to 40% of maximum value in the H-2-E type CONTROLAIR Valve. The remaining 32° of lever movement increases from 40% to its maximum value. Used in applications that require closer pressure adjustment at the low end of the delivery pressure range than at the high pressure end of the range.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor

WESTINGHOUSE AIR BRAKE COMPANY
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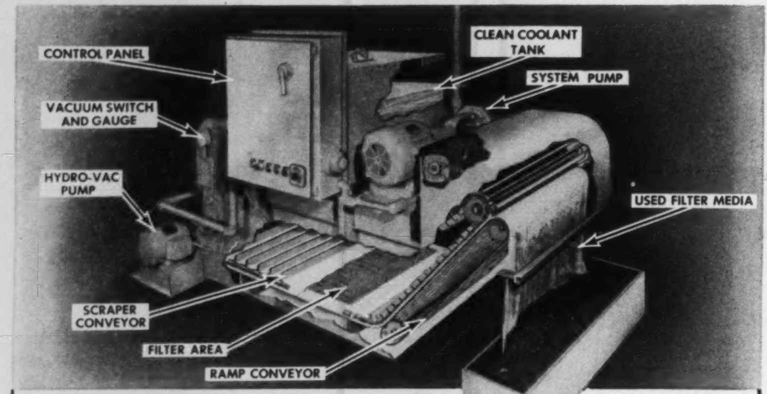

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- Completely automatic operation
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- Compact — with low liquid inlet
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- Fine degree of filtration
- Pressure and vacuum forces act on filter media
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HYDROMATION FILTER CO.

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Circle 733 on Page 19

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★ Multi-Spindle Boring ★ Single and Multi-Spindle Honing
★ Straight Line Multi-Drilling ★ Adjustable Spindle Drilling
★ Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
★ Special Multiple Operation Machine Tools

Twenty-Station, Ten-Unit Transfer Machine for boring, counterboring, chamfering and valve clearance operations on V-8 automotive engine blocks. (Shown)

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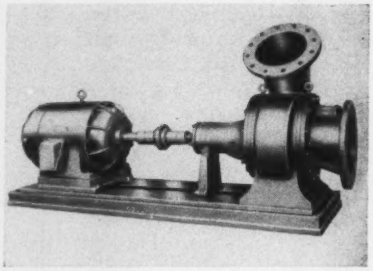

whether abrasive or nonabrasive. It can also handle thick liquids of all types such as paper stock, starches, slimes, and slurries. The pump will operate under conditions where temperatures up to 350 F and working pressures up to 400 psi are encountered. Unit is of the end-suction, vertically split-type construction, featuring back pullout assembly which gives accessibility to all rotating parts without disturbing pipe connections. It is available in capacities ranging up to 9500 gpm and for heads up to 220 feet. **Goulds Pumps Inc.**, 200 Black Brook Rd., Seneca Falls, N. Y.

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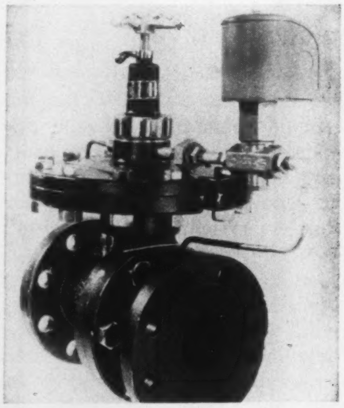
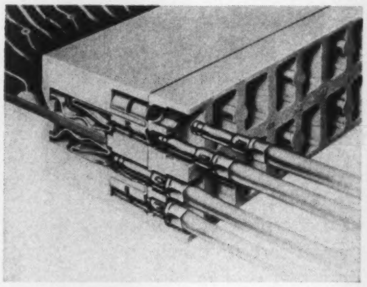


Solenoid Pilot

Solenoid actuated unit can be used for remote shut-off, remote start up, automatic safety shut-off, and combination pressure and temperature control. It is suitable for use on steam, air, and liquids for pressures to 250 psi and temperatures to 450 F. When the solenoid opens, it allows steam to enter the pilot chamber and operate the main valve as a normal pressure regulator. When the solenoid closes, the steam supply to the pilot is shut off and the main valve closes automatically. The regulator has stainless steel seats in both the solenoid and main valve, with straight through flow seats in the main valve. **OPW-Jordan,** 6013 Wiehe Rd., Cincinnati 13, Ohio.

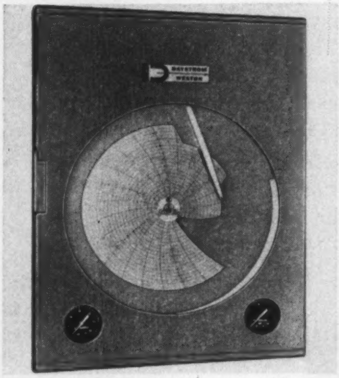
Circle 464 on Page 19



Printed Circuit Connector

Edge-type printed circuit connector features a bifurcated, undulating spring design which provides multipoint contact. Crimp-type snap-in Hyfen tips with insulation grips are used, eliminating the need for insulating sleeves. There are 1 or 2 tips for each board position on each side. The tips can accommodate combinations of wire sizes as well as single wires. Feature of the unit is a closed entry face on the board side which protects the spring and self-aligns warped printed circuit boards. **Omaton Div., Burndy Corp.,** Norwalk, Conn.

Circle 465 on Page 19



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Pneumatic programmer can handle one or two transmission sys-

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GREATER EFFICIENCY...
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If you're interested in getting top efficiency from your equipment while holding costs to a minimum, investigate the Baltric line of motors—without obligation! Just write...

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Circle 735 on Page 19

To the Executive
who watches his Competition closely . . .

Are you investigating Clad-Rex® Vinyl-Metal Laminates?

Don't wait *too* long! Because Clad-Rex really reduces manufacturing costs *and* increases product sales appeal. And *that* kind of advantage would be better yours than your competitor's. Many other manufacturing executives are already using Clad-Rex vinyl-metal laminates for electronic equipment cabinets . . . automotive trim . . . appliances . . . furniture, etc.

Here are the facts:

Clad-Rex is a calendered, semi-rigid poly-vinyl chloride film laminated to sheet metal. All alloys and tempers of aluminum and steel (including galvanized and aluminized) are commonly used. Other metals can be used where their special properties are important to end product performance.

The most obvious advantage of Clad-Rex vinyl-metal laminates is styling. It's unlimited! Simulated woodgrains and leathers as well as a wide variety of colors and textures in sparkling burnishes (including high metallics), or non-reflective matte finishes. You can design your own if you prefer!

Not so obvious, *but most important of all*—Clad-Rex vinyl-metal laminates are practical. There is no complex technique or special tooling required to fabricate Clad-Rex. It can be fabricated in almost as many ways as any *un*-finished sheet metal. Furthermore, and without charge, a Field Fabricating Engineer is provided to show your production people how easy it is to get into production with Clad-Rex.

Actually, Clad-Rex *simplifies* your manufacturing operations. It's finished before you get it. Movement of sub-assemblies, etc., through your plant becomes more direct—out of your dies into assembly.

Clad-Rex lowers your end product cost. Although Clad-Rex costs more than *un*finished metal coming into your plant, elimination of expensive handling and finishing adds up to *less cost* when your product is ready to ship. Clad-Rex resistance to abrasion often eliminates the rejects common to *un*finished or other pre-finished metals. This includes the costly efforts to salvage those rejects, too.

Your product may need these other characteristics of Clad-Rex vinyl-metal laminates—high dielectric strength, and resistance to the corrosion of acids, alkalis, and household detergents.

So, see for yourself. Write for details. No obligation, of course. Perhaps you won't be first in your field to begin using Clad-Rex. But why risk competitive disadvantage by being last?

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3-A

tems, transmits a 3-15 psi pneumatic signal, and can be used with single or double cams. The transmitter is available with interchangeable cams in either 1, 8, 12, 24-hour and 7-day cam drives. Model 7002 features sturdy bridge type pointer suspension, and all internal components are mounted on the baseplate. The instrument is furnished with universal mounts (flush or surface) and it is encased in a dust and moisture-resistant metal cabinet. A door stop limits opening swing to 135 degrees. **Weston Instruments Div., Daystrom Inc.,** 614 Frelinghuysen Ave., Newark 12, N. J.

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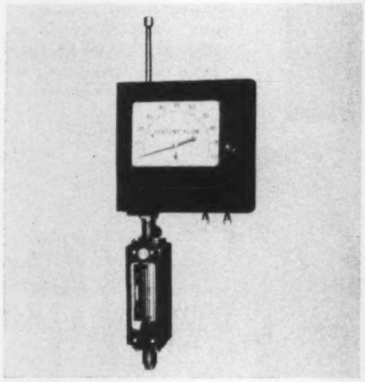


Transmitting Rotameter

Pneumatic instrument (Model 58) is suitable for signaling fluid rates of flow to remotely located recorders and controllers. Four calibration adjustments permit accurate field recalibration whenever basic operating conditions change. A feature of the position-balance type rotameter is a magnet design which provides an evenly-distributed magnetic field without drag on the metering float. The metering float has an extension rod which extends into the transmitter case. As the magnet in the extension rod moves up or down with the float, the movement is followed by follower magnets encased in the arm of the transmitter. The magnet arm operates a ball pilot in the transmitter unit. This ball pilot controls air pressure for accurate transmission of rates of flow. **Instrument Div., Schutte & Koerting Co.,** Cornwells Heights, Bucks County, Pa.

Circle 467 on Page 19

Magnetic Tape

Magnetic instrumentation tape features a long-wearing coating that minimizes oxide rub-off, reduces buildup of electrostatic charges, and resists high temperatures. The tape has been tested at temperatures ranging from −40 to 250 F, without showing binder deterioration. It is suitable for applications requiring oxide coatings which stand up under rugged conditions of high speed, temperature, and head tape pressure. The high temperature binder also makes the tape useful for long term storage of recorded data in areas which are not air-conditioned or humidity-controlled. Two types of tape are available in the Heavy-Duty Series—Models 198 and 199. Both have a 0.45 mil black oxide coating. Model 199 is designed for longer playing time, with a 1 mil polyester backing while Model 198 has a 1.5 mil backing. **Minnesota Mining & Mfg. Co.,** Dept. EO-79, 900 Bush Ave., St. Paul 6, Minn.

Circle 468 on Page 19

HANSEN
SERIES
RL
QUICK-CONNECTIVE
RING LOCK
COUPLING

OPEN
HANSEN

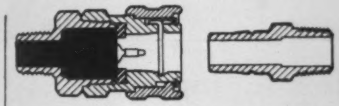
The coupling that's

Tougher... Lighter... Smaller

handles more air...with minimum pressure drop

- and gives you all these other advantages -

Has fewer parts. Locking ring provides positive lock . . . tight fit . . . minimum wear. Equipped with automatic sleeve lock.



Instant Automatic Flow or Shut-Off

•

Write for the Hansen Catalog

Handles any job in your shop using ¾" to ⅛" connections— from the air line to the air tool.

All Series 2-RL Sockets and Plugs are interchangeable — likewise all Series 3-RL Sockets and Plugs. Eliminates any need for various size couplings in hook-up — makes it easy to keep stock parts in balance — holds inventories to a minimum.

HANSEN
COUPLINGS

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings —including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.

Representatives in Principal Cities . . . see Yellow Pages

'60 *Booth 2019*

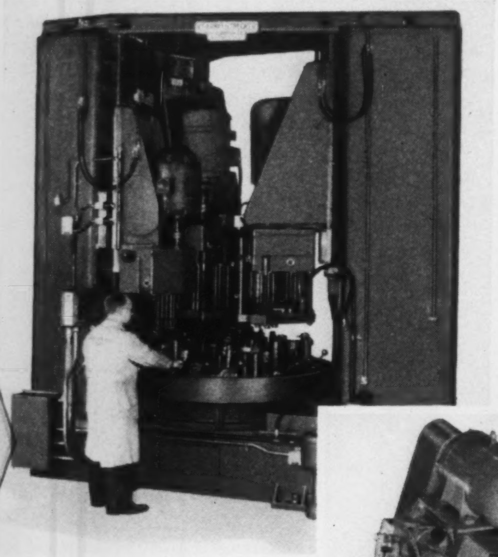
SINCE 1915 **QUICK-CONNECTIVE FLUID LINE COUPLINGS**

THE HANSEN MANUFACTURING COMPANY
4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle 737 on Page 19

KEARNEY & TRECKER *builds production*
MACHINE TOOLS FOR EVERY INDUSTRY

Since 1898 . . . Kearney & Trecker Customer Engineering Service — supported by an outstanding staff of engineers experienced in production milling machine design and application — combined with the finest and latest machine tools in an ultra modern plant is always ready to solve your production problems.

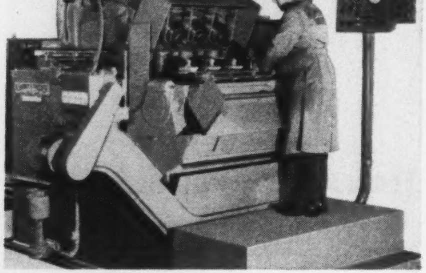


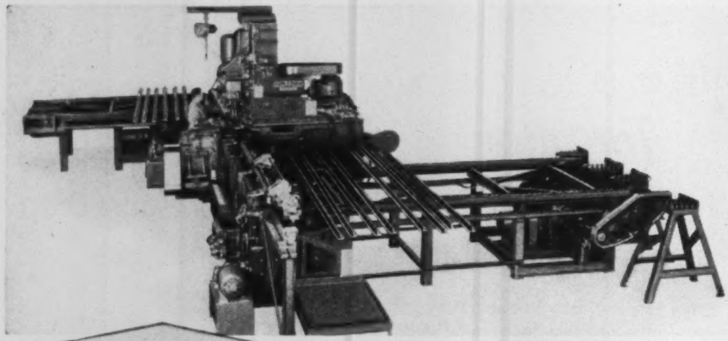
Automotive Industry

this 88 spindle, 3 vertical head machine performs drilling, chamfering, counterboring, trepanning, spot-facing, reaming and tapping operation on a differention case and cover. PRODUCTION — 67 cases, 67 covers per hour.

Oil Industry

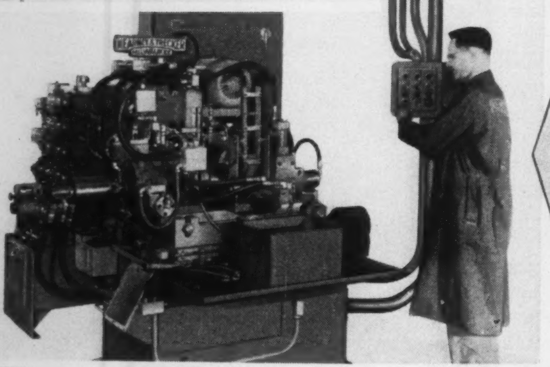
automatic 4-spindle milling machine mills 4 rock bit cones *simultaneously*... in a trunnion-type fixture having 4 work-piece spindles. PRODUCTION — a constant flow of this expendable type tool to meet the steady demand.





Elevator Industry

12 spindle automatic transfer machine mills mating tongue and groove on ends of elevator guide rail-drills mounting holes in rail flanges—for continuous rail mounting. PRODUCTION—28 completely machined rails per hour — 180% increase over old method.



Tool Industry

Flutes and shank squares are milled on tap blanks by this automatic machine. Tap blanks are hopper loaded and automatically unloaded. RESULT—greatly increased hourly production.

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®

Write for bulletin SMD-57 on your company letterhead.

KEARNEY & TRECKER CORPORATION
Special Machinery Division
6784 W. National Avenue • Milwaukee 14, Wisconsin

Circle 738 on Page 19

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Electric Controls

Warner Electric Brake & Clutch Co., Beloit, Wis.—8 page bulletin—Bulletin P-75 describes line of standard, special, and custom controls used to actuate company's electric brakes and clutches. Notes are given on how to select the proper control, covering such factors as the units to be controlled, ac input, dc voltage, and over-all dimensions.

Circle 469 on Page 19

Chains & Sprockets

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—44 page catalog—Data are contained in Book 2757 on line of roller chains and sprockets. Sizes and types of roller chains listed include: Single, double, triple, and quadruple strand; heavy series roller chains; corrosion-resistant stainless steel and bronze roller chains; double pitch roller chains; various types of flat-top conveyor chains; and leaf chain. Sprockets listed include: Finished bore, taper lock, mandrel bore, type D (removable segments), and shear pin types.

Circle 470 on Page 19

Relays

Diaphlex Div., Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.—41 page catalog—Data are given on 30 types of relays. Some of the types described include: Polarized, general-purpose, multipurpose, twin-contact, and snap action. Over 1000 variations are available; the variations being in spring arrangements, timing, coil voltage, and contact ratings. Tables list part numbers, and diagrams show relay outlines and over-all dimensions.

Circle 471 on Page 19

Indexing Components

Ferguson Machine Corp., 7818 Maplewood Industrial Court, St. Louis 17, Mo.—40 page catalog—Data are given in Catalog 160 on standard roller gear drive indexing mechanisms, high speed precision index tables, in-line transfer machines, and allied equipment. Notes are given on how to select the proper drive, how to calculate load requirements, and the procedure for ordering a drive. Features described include: Double enveloping worm gear type speed reducer which mounts directly to the cam shaft of an index table; a direct power unit with motor, clutch-brake, and reducer which can be mounted directly to the index table cam shaft; and a pivot-mounted power transmission system that swings out from a machine base for maximum accessibility.

Circle 472 on Page 19

Vibrating Dryers & Coolers

Jeffrey Mfg. Co., 956 N. Fourth St., Columbus 16, Ohio—32 page catalog—Electric and mechanical vibrating type coolers and dryers—both the direct and indirect type—are described in Catalog 953. Basic drying principles are expained, and a pilot unit rental system is outlined. This system permits firms to simulate actual production conditions in their own plants. Notes are given on auxiliary equipment such as feeders, conveyors, magnetic separators, packers, and controls.

Circle 473 on Page 19

Dust Control

Dracco Div., Fuller Co., Harvard Avenue & E. 116th St., Cleveland 5, Ohio—28 page catalog—Dust control equipment described in Bulletin 805 includes multibag filters with intermittent or continuous operation; uni-filters which provide de-centralized dust collection from widely scattered sources; glass-bag filters which collect hot, corrosive dust and fumes to 600 F, and cyclonic collectors for either vacuum or pressure operation. Data are given on special collectors and accessories such as bin vibrators, discharge boxes, and rotary feeders.

Circle 474 on Page 19

Electrical Parts

Ohmite Mfg. Co., 3965 Howard St., Skokie, Ill.—32 page catalog—Data are given in Catalog 30A on line of rheostats, potentiometers, resistors, relays, variable transformers, tap switches, and chokes. Miscellaneous items outlined include: Adjustable lugs, mounting brackets, and dial plates and knobs. Three types of capacitors are listed—wire, slug, and foil. New products covered include: Metal film and molded wire-wound precision resistors and variable transformers.

Circle 475 on Page 19

Supervisory Control

Ascop Div., Electro-Mechanical Research Inc., P. O. Box 44, Princeton, N. J.—12 page booklet—Subject of Bulletin SC3M020 is a supervisory control system that is applicable in pipeline transmission systems on oil, gas, and product lines; in unattended electric utility substations; at microwave relay stations; and similar unattended stations. Details are given on the operating sequences for the various types of control and supervision which can be specified. Block diagrams help explain the operation.

Circle 476 on Page 19

Analog-to-Digital Processor

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.—4 page pamphlet—Subject of Bulletin 3004 is MicroSadic, a high-speed analog-to-digital processor which acquires, digitizes, and stores data at a maximum rate of 10,000 samples per second. Design features of the instrument are described, and the theory of operation is explained, aided by block diagrams.

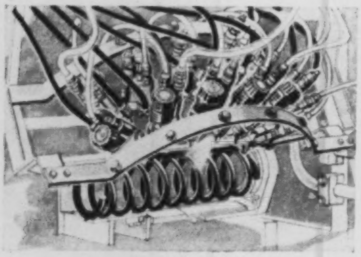
Circle 477 on Page 19

Vertical Boring Mills

Consolidated Machine Tool Div., Farrel-Birmingham Co. Inc., 565 Blossom Rd., Rochester 10, N. Y.—42 page catalog—Four groups of vertical boring mills ranging in capacities from a swing of 7 feet to 42 feet and larger are described in Bulletin 1220. The general construction of the mills is explained, and features of

DeVilbiss spray guns apply almost anything that pours — automatically!

Automated color-coding



Equipped with 12 DeVilbiss automatic spray guns, this Electronic Spring Tester color-codes helical auto springs. Compressive stress absorbed by each spring is measured, then transmitted to an electronic selector, which actuates a specific gun for color-coding it. Spray cycle takes less than half a second! Investigate color-coding or other automatic applications with DeVilbiss spray guns. Contact our nearest representative. The DeVilbiss Company, Toledo 1, Ohio. Offices in principal cities.

FOR TOTAL SERVICE, CALL

DEVILBISS

Circle 739 on Page 19

the drives, beds, and tables in the individual groups are discussed. Dimensional drawings and specifications are also included.

Circle 478 on Page 19

Machine Tools

Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.—12 page booklet—Machine tools described in Catalog 60 include: Horizontal boring, drilling, and milling machines with accessories; vertical turret lathes; vertical boring mills; upright and radial drilling machines; planer mills; and planers. All machines are available with punched tape, discrete positioning, or magnetic tape continuous-path controls. In the line of equipment are large size units such as: 34-inch column size radial drilling machines; 20-ft vertical boring mills; and 14-inch spindle diameter horizontal boring, drilling, and milling machines.

Circle 479 on Page 19

Controlled Speed Systems

U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.—8 page bulletin—AC controlled speed systems, designated Varidyne, are described. It shows how the system uses ac characteristics to provide adjustable speeds by converting fixed-speed ac motors to adjustable speeds on either existing equipment or original equipment. It also explains how the system provides inherent speed co-ordination in multimotor installations, and, in such applications, automatically distributes loads equally.

Circle 480 on Page 19

Magnetic Pulleys

Dings Magnetic Separator Co., 4740 W. Electric Ave., Milwaukee 46, Wis.—8 page bulletin—Factors governing the selection of electromagnetic pulleys or nonelectric ceramic type pulleys are discussed in Catalog C-2000. Charts are given showing how to select the proper pulley in relation to belt speed, belt width, and burden. Features of a new ceramic magnet material, designated Ceramox V, are also described.

Circle 481 on Page 19

Filling Equipment

Arthur Colton Co., 3400 E. Lafayette Ave., Detroit 7, Mich.—8 page bulletin—Filling equipment for the pharmaceutical, chemical, cosmetic, paint, plastics, and food industries is outlined in Catalog AC-60. This equipment includes automatic metal and plastic tube fillers; closers and crimpers for pastes, creams, and liquids; single, twin, and multiple liquid fillers; and single-operation fillers, closers, and crimpers.

Circle 482 on Page 19

Mercury Switch Controls

Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.—56 page catalog—Mercury switch equipped controls outlined in Catalog 860 are for single-stage pressure, two-stage pressure, differential pressure, single-stage temperature, two-stage temperature, liquid level, and mechanical movement. Charts list pressure, temperature, and electrical ratings. Data are also given on line of hermetically sealed mercury switches.

Circle 483 on Page 19

Stationary Compressors

Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.—24 page catalog—Subject of Bulletin A-72 is Model WN-114, a semi-radially constructed stationary compressor. Data are given on three models ranging from 1385 cfm to 1948 cfm at 125 psi. The two-section inter-cooler and force-feed lubrication system are explained. Notes are also given on accessories and special equipment.

Circle 484 on Page 19

Washing & Phosphatizing Units

Ramco Equipment Corp., Div., Randall Mfg. Co. Inc., 1379 Lafayette Ave., New York 59, N. Y.—8 page bulletin—Power spray washing and phosphatizing equipment is described in Bulletin 659-1. Data are given on selecting the proper unit from 5 groups, with 6 process cycle time models in each group. Schematic drawings show 4 typical installations incorporating power spray washers and phosphatizing equipment, paint and spray booths, dry off ovens, and conveyors.

Circle 485 on Page 19

Flow Meters

Brooks Rotameter Co., Hatfield, Pa.—6 page pamphlet—Direct-reading, flow-measuring rotameters for pressures up to 45,000 psi and temperatures to 1000F are outlined in Bulletin 110. Illustrations show the various types of meters in their specific areas of application. The system of interchangeable accessories is explained, showing how these units are adaptable to instrumentation needs.

Circle 486 on Page 19

Pneumatic Conveying

Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.—4 page pamphlet—Pneumatic conveying systems are described in Bulletin 143-B. Charts list capacities of the systems, and schematic drawings show typical stationary and portable systems. Other illustrations show various applications of the pneumatic conveyors.

Circle 487 on Page 19

Core Memories

Telemeter Magnetics Inc., P. O. Box 329, Culver City, Calif.—4 page pamphlet—Subject of Bulletin DF 115.1 is a series of general purpose core memories, designated Type RB. The units are available in a wide range of sizes from 128 to 1024 words and from 4 to 24 bits per word. They operate at rates up to 125 kc and provide both random access and sequential types of operation. A block diagram shows the timing cycle of the unit.

Circle 488 on Page 19

Electronic Computing System

Data Processing Div., Royal McBee Corp., Port Chester, N. Y.—6 page pamphlet—Subject of Bulletin S-483 is Model RPC-4000, a transistorized, electronic computing system. Some of the features pointed out include the magnetic drum storage which can hold 8008 words; the index register for automatic high-speed address modification; the high-speed input and output, with a reading speed up to 500 characters per second and 300 characters per second punching, with optional equipment.

Circle 489 on Page 19

Substation Equipment

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.—60 page catalog—Data are given on molded case circuit breakers, individually-enclosed low-voltage power circuit breakers, and engineered products such as interrupter switches, transformers, unit substations, high-voltage switchgear, low-voltage switchgear, oil circuit breakers, testing devices, and interlocks. Selection charts for the circuit breakers and low-voltage power circuit breakers cover ratings, overcurrent devices, attachments, and modifications.

Circle 490 on Page 19

Fittings

Imperial Brass Mfg. Co., 6300 W. Howard St., Chicago 48, Ill.—44 page catalog—Line of butt-joint fittings described in Catalog 3108 have held pressures in excess of 30,000 psi, without failure. Over 250 styles and sizes are listed. Data are included on Braze-seal fittings for extra high pressure and temperature. Three port sealing methods are discussed, and assembly instructions are given. Formulae for calculating maximum surge pressures are noted, and laboratory test reports are summarized.

Circle 491 on Page 19

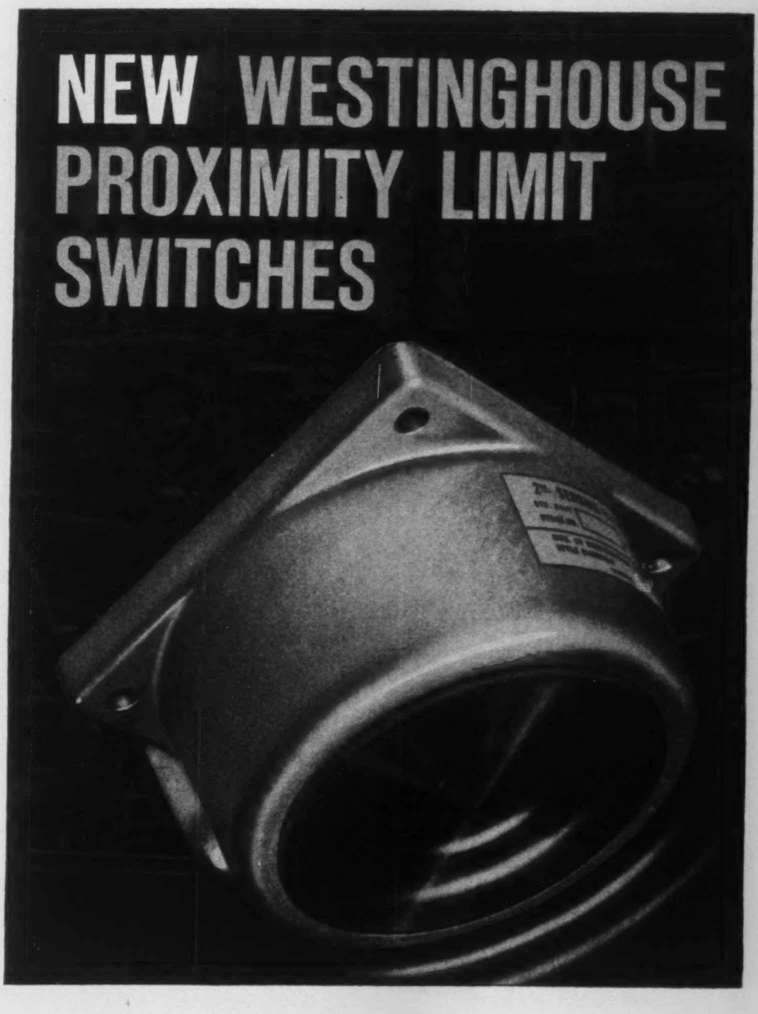
Lubrication Systems

Farval Div., Eaton Mfg. Co., 3300 East 80th St., Cleveland 4, Ohio—24 page catalog—Line of centralized systems of lubrication is described in Bulletin 26-T. Details explain the operation of the Dualine measuring valve. Illustration shows a typical system layout, and a schematic drawing shows an arrangement of system components. Part numbers and sizes of fittings and accessories are listed.

Circle 492 on Page 19

Welding Machines

Taylor-Winfield Corp., Warren, Ohio—12 page booklet—Multispot and projection



NEW WESTINGHOUSE PROXIMITY LIMIT SWITCHES

...OUTLAST MACHINES THEY CONTROL

Why? They won't wear out. No tubes . . . no moving parts . . . no contacts to spark, pit or wear. They're corrosion resistant . . . sneer at dust, dirt or oil mist . . . could operate under water. They've passed military shock and vibration tests . . . fit most applications. Two sizes of sensing heads available for tripping distances within ½ inch or within 2 inches.

Cost? Westinghouse proximity limit switches cost a little more—but pay for themselves over and over again because they banish expensive machine down time for switch service and replacement.

CALL TODAY for the facts on the new Westinghouse proximity limit switches. Your nearest Westinghouse sales engineer will show you how they can save you time and money. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-25002

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

Circle 740 on Page 19

resistance welding machines are outlined in Bulletin 8-413. Data such as end products, type of operation, production rate, and specifications are given for 32 different machines. Features described incude: Automatic loading and inspection; special welding techniques; spot, projection, and seam welds; resistance brazing; and hot upsetting operations.

Circle 493 on Page 19

Motor Control Centers

Automatic Control Co., St. Paul 4, Minn.—16 page booklet—Three designs of motor control centers are described in Bulletin SPM-1-1159. These consist of a modular, draw-out uni-cell control center; a modular fixed mounted uni-cell control center; and a panel mounted control center. Interior and exterior features and construction details of the different units are given. The flexibility of circuitry is discussed, and methods of figuring combinations are explained.

Circle 494 on Page 19

Filtration Equipment

Commercial Filters Corp., Melrose 76, Mass.—8 page bulletin—Industrial filtration equipment outlined in Bulletin GEO-506A is available for operating pressures up to 4000 psi, for flow rates up to 2000 gpm, and for temperatures up to 750F. This includes filters for liquids, compressed air, and gases. Various types of filter tubes and media are noted.

Circle 495 on Page 19

Flexible Couplings

Thomas Flexible Coupling Co., Warren, Pa.—48 page catalog—Data are contained in Catalog 60 on eight groups of couplings. This includes miniature couplings, light load couplings for motor and turbine drives, low speed heavy duty couplings for engines and low side of speed reducers, full floating shaft couplings, and semifloating shaft couplings. Tables classifying loads are given; as are facts about dynamic balancing.

Circle 496 on Page 19

Thermoforming Techniques

Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.—22 page booklet—Details are given on various methods of vacuum forming. These include vacuum forming into a cavity, drape forming, vacuum snap-back forming, billow forming, blow-up vacuum reverse forming, blow-up vacuum reverse into a cavity, and male assist pressure forming. Numerous sketches help explain the different methods.

Circle 497 on Page 19

Time Delay Relays

Tempo Instrument Inc., P. O. Box 338, Hicksville, N. Y.—8 page bulletin—Line of electronic time delay relays described in Bulletin 5905 is available with overlapping time delay ranges, each capable of a 20 to 1 adjustment range. The manufacturing and assembly process is described, and the circuit design is explained, aided by performance graphs. Dimensional drawings show sizes, mountings, and terminal styles.

Circle 498 on Page 19

Process Controllers

Dynapar Corp., 7312 N. Ridgeway Ave., Skokie, Ill.—24 page catalog—Data are given on transistorized digital preset counters, process controllers, and other sensing devices which are used to provide precise numerical readout and actuation of automatic control functions. Details are given on applications such as measuring length, belt speed, rpm, and other analog quantities; automatic cutting-to-length; high-speed bottle cap counting and feed control; automatic metal elongation measurement and control; measuring ratios of paper roll speeds and controls; counting metal strapping seals—plus automatic jam control; wire footage-fault measurements and reel control; and automatic coil winding.

Circle 499 on Page 19

Broaching Fixtures

National Broach & Machine Co., 5600 St. Jean Ave., Detroit 13, Mich.—12 page booklet—Selfcontained, air-powered broaching fixtures described in Catalog B60-1 are suitable for producing keyways, slots, flats, small splines, oil grooves, serrations, deburred surfaces, and holes of various shapes. Details are given on typical applications and are accompanied by line drawings.

Circle 500 on Page 19

Voltage Digitizers

Adage Inc., 292 Main St., Cambridge 42, Mass.—6 page pamphlet—Voltage digitizers outlined in Bulletin G1-D use digital logic and readout for high-speed precision measurement of analog signals. The instruments have a speed up to 10 kc conversion rate, an accuracy of ±0.01 per cent of ±full scale, and a sensitivity of 1 volt full scale; up to 100 mu v at 0.1 microampere resolution. Data are listed in table form showing inputs, outputs, accuracy, and speed.

Circle 501 on Page 19

Air Control Valves

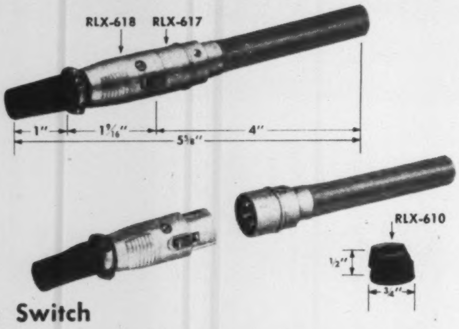
Hunt Valve Co., Salem, Ohio—4 page pamphlet—Subject of Bulletin 594 is a $\frac{1}{2}$-inch air control valve, designated Model PDQ. Instructions tell how to replace the entire valve, including the plug-in solenoid, in less than 30 seconds. Complete repacking of the valve and pilot section can be done in less than one minute without tools. Cutaway photos show flow in both energized and de-energized positions. Mounting views and dimensions are also included.

Circle 502 on Page 19

Core-Transistor Converters

Magnetics Inc., Butler, Pa.—16 page booklet—Details on the design of tape-

POST
DECITRON
ELECTRONIC
PRODUCTS



NEW!

MH-2-P Magnetic Switch

A new and improved sensing device . . . neatly contained in an epoxy resin shell. The MH-2-P is ideal for industrial applications and is easier to mount in areas of limited access. A quick disconnect Cannon connector eliminates elbow type construction.

The new epoxy resin housing results in less magnetic flux and increased sensitivity. As a consequence, smaller magnets can be used and manufacturer reports a minimum magnetic field transient time of only 8 milliseconds is needed to activate the switch. Operating life is in excess of one billion operations.

Write For Bulletin MH-2-P

Decitron

ELECTRONIC PRODUCTS DIVISION

Post Machinery Co. | 175 Eliot St., Beverly, Mass.

Circle 741 on Page 19

wound, core-transistor converters are given in booklet entitled, "Designing DC-DC Converters." Converter design factors are covered, including transistor selection and characteristics of magnetic cores. Two theoretical case histories are described, covering design of a power converter, and of a dc to dc high voltage supply. Charts list curves developed from a single tape-wound core, showing magnetizing current as a function of frequency.

Circle 503 on Page 19

Chains & Sprockets

Dodge Mfg. Corp., Mishawaka, Ind.—56 page catalog—Line of roller chains, chain couplings, and taper-lock sprockets is described in Bulletin A691. Types of roller chains include: Single strand, double strand, single strand heavy series, double pitch drive, double pitch conveyor, and double pitch conveyor with large rollers. Types of sprockets are steel plate and bored-to-size. Instructions are given on the installation of roller chain drives, calculation of center distances, and lubrication and maintenance.

Circle 504 on Page 19

Conveyors

Standard Conveyor Co., North St. Paul 9, Minn.—22 page booklet—Line of integrated package conveyor units described in Bulletin 112 can be made into conveyor systems to suit individual applications. Some of the types of conveyors which can be combined include: Level belt, inclined belt, and live roller conveyors. Data are given to help make the proper conveyor selection, and a chart indicates the width of curved section recommended for commodities of given lengths and widths.

Circle 505 on Page 19

Relay & Switch Enclosures

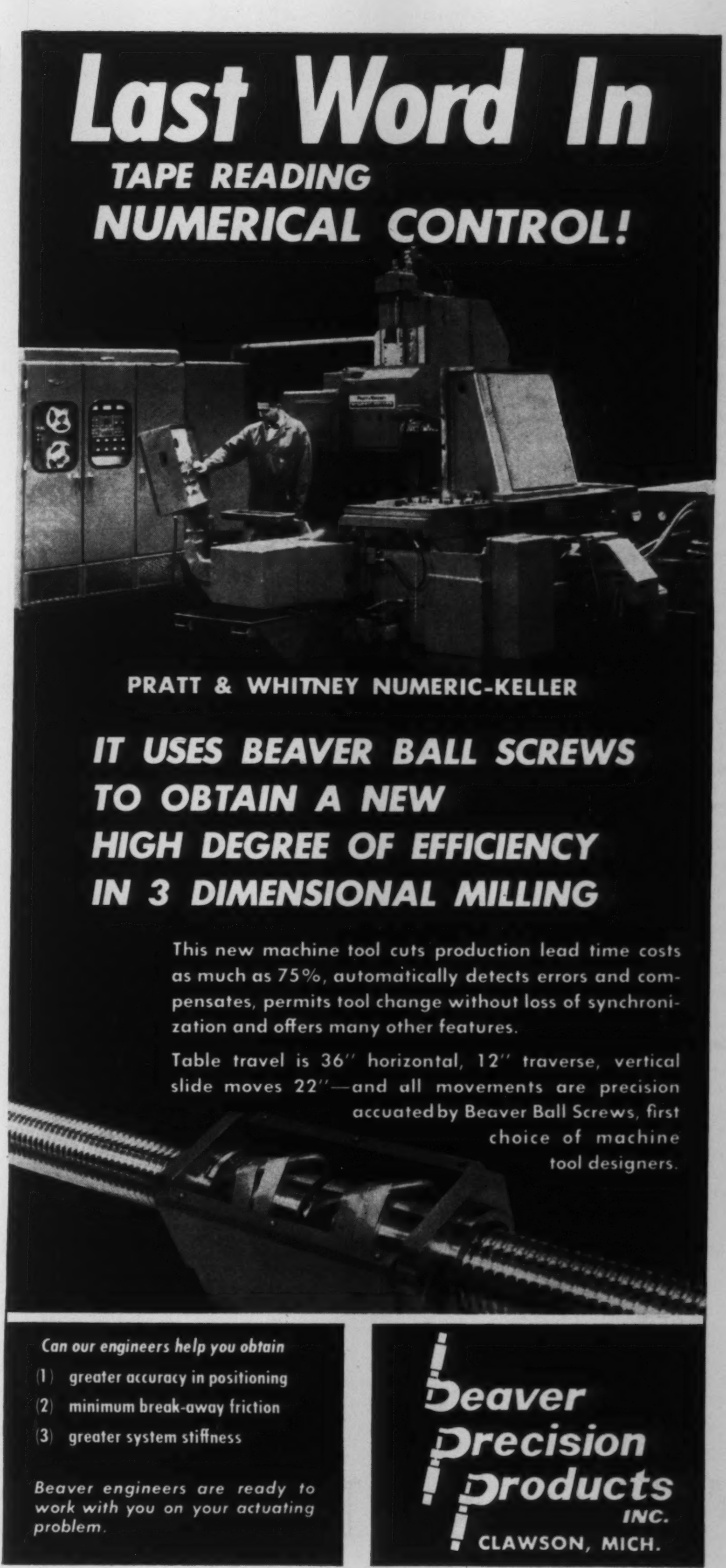
Automatic Electric, Northlake, Ill.—32 page catalog—Hermetically sealed and protective enclosures for relays and switches are described and illustrated in Catalog 4083-A. The enclosures protect against dust and dirt, moisture and high humidity, frost, fungus growth, explosive gas, corrosive spray, reduced air pressure, and tampering. Dimensional drawings, wiring diagrams, and notes on mating sockets are given.

Circle 506 on Page 19

Control Panels

Fuller Co., Catasauqua, Pa.—12 page booklet—Control panels for materials handling systems are described in Bulletin G-9. Data are given on four basic types—a walk-in master control panel, floor and wall-mounted types, and an explosion-proof type. Schematic drawings show systems used to control unloading, reclaiming, and processing of materials in a brewery. Other applications displayed include: A panel control of a pelletizing plant for taconite; raw material feed in a cement mill; handling of plastic cube pellets, starch, cellulose acetate, metal and grits, and alumina.

Circle 507 on Page 19



Last Word In
TAPE READING
NUMERICAL CONTROL!

PRATT & WHITNEY NUMERIC-KELLER

IT USES BEAVER BALL SCREWS
TO OBTAIN A NEW
HIGH DEGREE OF EFFICIENCY
IN 3 DIMENSIONAL MILLING

This new machine tool cuts production lead time costs as much as 75%, automatically detects errors and compensates, permits tool change without loss of synchronization and offers many other features.

Table travel is 36" horizontal, 12" traverse, vertical slide moves 22"—and all movements are precision accuated by Beaver Ball Screws, first choice of machine tool designers.

Can our engineers help you obtain
(1) greater accuracy in positioning
(2) minimum break-away friction
(3) greater system stiffness

Beaver engineers are ready to work with you on your actuating problem.

Beaver
Precision
Products
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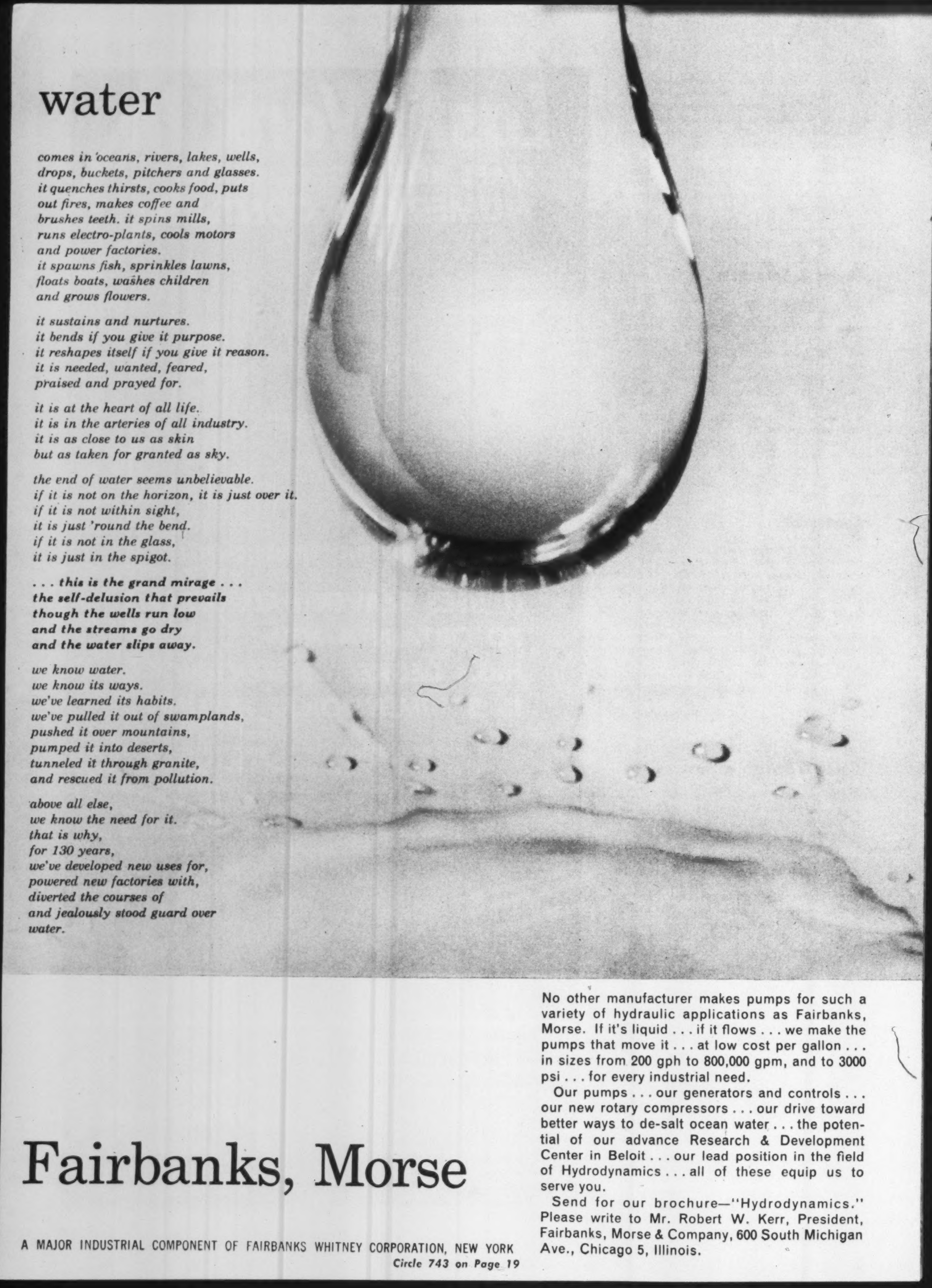
CLAWSON, MICH.

Circle 742 on Page 19



water

comes in oceans, rivers, lakes, wells,
drops, buckets, pitchers and glasses.
it quenches thirsts, cooks food, puts
out fires, makes coffee and
brushes teeth. it spins mills,
runs electro-plants, cools motors
and power factories.
it spawns fish, sprinkles lawns,
floats boats, washes children
and grows flowers.

it sustains and nurtures.
it bends if you give it purpose.
it reshapes itself if you give it reason.
it is needed, wanted, feared,
praised and prayed for.

it is at the heart of all life.
it is in the arteries of all industry.
it is as close to us as skin
but as taken for granted as sky.

the end of water seems unbelievable.
if it is not on the horizon, it is just over it.
if it is not within sight,
it is just 'round the bend.
if it is not in the glass,
it is just in the spigot.

. . . this is the grand mirage . . .
the self-delusion that prevails
though the wells run low
and the streams go dry
and the water slips away.

we know water.
we know its ways.
we've learned its habits.
we've pulled it out of swamplands,
pushed it over mountains,
pumped it into deserts,
tunneled it through granite,
and rescued it from pollution.

above all else,
we know the need for it.
that is why,
for 130 years,
we've developed new uses for,
powered new factories with,
diverted the courses of
and jealously stood guard over
water.

Fairbanks, Morse

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

Circle 743 on Page 19

No other manufacturer makes pumps for such a variety of hydraulic applications as Fairbanks, Morse. If it's liquid . . . if it flows . . . we make the pumps that move it . . . at low cost per gallon . . . in sizes from 200 gph to 800,000 gpm, and to 3000 psi . . . for every industrial need.

Our pumps . . . our generators and controls . . . our new rotary compressors . . . our drive toward better ways to de-salt ocean water . . . the potential of our advance Research & Development Center in Beloit . . . our lead position in the field of Hydrodynamics . . . all of these equip us to serve you.

Send for our brochure—"Hydrodynamics." Please write to Mr. Robert W. Kerr, President, Fairbanks, Morse & Company, 600 South Michigan Ave., Chicago 5, Illinois.

AUTOMATION abstracts

FEATURES OF A PROCESS CONTROL SYSTEM OPERATED BY A COMPUTER

By K. G. HARPLE and R. G. LEX JR.
Research & Development Dept.
Leeds & Northrup Co.
Philadelphia, Pa.

THE DESIGNER of a computer control system for continuous operation in an industrial process must assume two roles. One role is that of the computer expert responsible for assuring that the best computer techniques are used. The other role is that of the process application expert responsible for assuring that the system conforms to the best in process design practices.

The computer expert will use the best in components and circuit design to meet the stringent reliability and performance requirements. He will employ solid state components, circuits will be conservatively rated, and particular attention will be given to manufacturing techniques. The computer expert feels that he now has equipment acceptable for continuous operation in an industrial process.

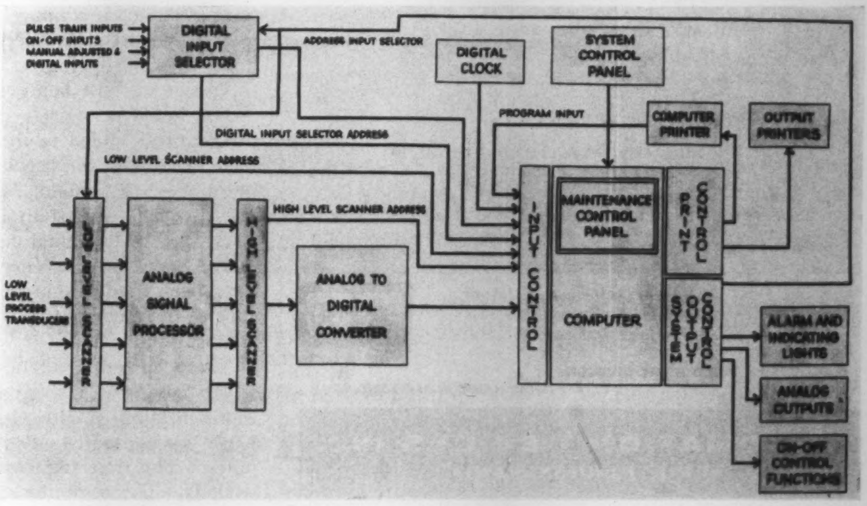
While the process expert may agree that the equipment will exhibit excellent reliability, he will quickly ask what error checking and fail-safe performance techniques have been used. He will point out that even the most reliable process equipment employs interlocks to provide fail-safe operation. On this basis, the process expert will insist that these features be incorporated in the computer control system before it is installed on a process.

The system described in this paper was designed using both points of view. The circuits in the system were exhaustively designed. Error detection and correction were incorporated through programming and logical design techniques. The computer in the system is able to monitor itself and the input-output equipment continuously for random errors and component failures. In addition, all system outputs which affect process operation have nonvolatile memory to provide for fail-safe performance. The system also continues to perform essential alarm monitoring functions even when its more complex logical sections are removed from operation.

The block diagram of *Fig.* 1 shows the major components of the system and indicates the flow of control signals and data. In brief, the operation of the system is as follows. All primary variables are connected by the low level scanner to the analog signal processor which provides input signal suppression, isolation, and amplification. The high level output from the signal processor is sequenced to an analog to digital converter by a high level scanner. Digital data from the analog to digital converter and a digital address corresponding to the data are transmitted to the computer input section for entry into the computer.

All analog and digital data are fed into the computer as demanded by the computer program. Preprogrammed calculations are performed by the computer on all data. The results of the calculations can be stored in memory for later use or can be used to make decisions for immediate control action.

As required, the computer can initiate scheduled or on-demand printouts on any of several available print-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ON-OFF INPUTS
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HIGH LEVEL SCANNER ADDRESS
LOW LEVEL PROCESS TRANSDUCERS
LOW LEVEL SCANNER
ANALOG SIGNAL PROCESSOR
HIGH LEVEL SCANNER
ANALOG TO DIGITAL CONVERTER
INPUT CONTROL
MAINTENANCE CONTROL PANEL
COMPUTER
PRINT CONTROL
SYSTEM OUTPUT CONTROL
ALARM AND INDICATING LIGHTS
ANALOG OUTPUTS
ON-OFF CONTROL FUNCTIONS

Fig. 1—Block diagram indicates major components and flow of signals and data in process control system. Operation of entire system is controlled by the computer.

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ers. The computer can initiate control actions by actuating on-off outputs to start and stop equipment or by readjusting the set point of a local analog controller.

System Components

All analog process variables are switched by the low level scanner. Normally the low level scanner samples five points simultaneously at a rate of approximately one group per second. If faster scanning rates are desirable, the number of points sampled simultaneously would be increased. The basic system has been designed to handle a maximum of 1275 low level analog inputs. Each low level input signal is switched through a separate double pole contact of a specially designed 12-pole mercury-wetted contact relay.

Scanner selection is normally controlled by the computer. This permits the computer to change the scanner sequence as changing process operation dictates. A digital address, corresponding to the group of input points selected, is also generated by using contacts on the mercury-wetted relay. This address is used by the computer as a check on the scanner selection circuitry and the scanning relays.

The analog signal processor serves three system functions—zero suppression and reference temperature compensation, input signal isolation, and input signal amplification. The input signals may have a basic maximum range of 0 to 100 mv. For a scanning rate of five inputs per second, five input amplifiers are used in the signal processor to raise the low level input signals to a 0 to 10 volt dc range which is required by the analog to digital converter. The amplifiers also isolate the signal leads from the computer system to reduce errors that may be caused by potential differences between transducer grounds and the computer system ground. Ten amplifiers are required to obtain a scanning rate of ten points per second. A high level scanner switches the output of the five input amplifiers to the analog to digital converter. High speed mercury-wetted contact relays are employed as switching devices. An address generated by relay contacts of the high level scanner is used by the computer to check the operation of the high level scanner control circuitry and relays.

The analog to digital converter accepts the outputs of the input amplifiers in sequence and converts this analog signal to a binary representation. The conversion is performed by successively comparing the analog input to a fixed progression of precision currents, each successive current being one-half the value of the preceding current. Each precision current when it is turned on is added to the sum of those currents which have been left on previously. The standard current last turned on remains on if the sum of the currents is less than the analog input; it is turned off if the sum is greater. The remaining standard currents are tried in the same way. When all of the standard currents have been tried, the arrangement of the switches which control these currents is the digital representation of the analog input.

These current switches are controlled by flip-flops which comprise a shift register. Therefore, the digital representation is also contained in the shift register, ready for computer entry when requested by the computer. The time required for a conversion is 1.5 milliseconds. The computer can run preprogrammed checks on the converted digital data to check both converter and input amplifier operation.

The digital input selector connects all digital inputs to the input control section of the computer. Digital inputs can consist of contact closures from the process, pulse train counter inputs, or manually adjusted digital inputs. The basic system has been designed to handle a maximum of 255 counter and manually adjusted inputs or 2040 *On-Off* inputs. Digital inputs can be read into the computer at a maximum rate of 480 inputs per second.

The digital input selector is controlled by the computer. In applications such as automatic start-up, the sequence of examining on-off inputs will change as emergencies arise or process conditions change. A standard digital input also permits the computer to check the circuitry which controls digital data entry into the computer.

Alarm detection circuitry is external to the computer. Alarm settings are entered on a pinboard. As the converter is making a data conversion, a digital alarm comparison is made. Under normal operation if an alarm, either high or low, is detected, an annunciator light is immediately actuated, and a signal is transmitted to the computer. The computer can execute an off-normal printout and take whatever action is required to correct the off-normal.

The operation of the entire system is controlled by the computer. We may consider the operations the computer performs as consisting of two basic parts: One, the routine mechanics of information handling. Two, the processing of the information in accordance with the requirements of a specific application.

In the first category, the computer performs the following functions:

1. Selects the order and timing of reading input signals.
2. Checks the address of the incoming points to verify operation of the input switching, and periodically checks the accuracy of the measurement and conversion circuits by calling for standard input signals.
3. Transmits information to the operator either periodically, on demand, or when an abnormal situation occurs in the process. Operator information is presented in both printed log form and on panel indicators.
4. Transmits information to the process, both digitally, in the case of *On-Off* control functions, and after digital to analog conversion, in the case of resetting analog control set points.

The functions which the computer performs in processing information for specific applications may be briefly summarized under three general classes:

1. Process data reduction including operating guide calculations. Such calculations typically involve complex algebraic relationships between the process variables.
2. Program Controller. Process start-up and shutdown procedures typically involve a complex series of yes-no decisions. Such decisions may be made rapidly and consistently by an appropriate computer program. Either completely automatic operation may be obtained, or the results of computer decisions can be made available as instructions to the operator.
3. Process Optimization. This is the most complex of the computer's functions. Today, four general approaches are in use, which will be listed in order of decreasing knowledge of

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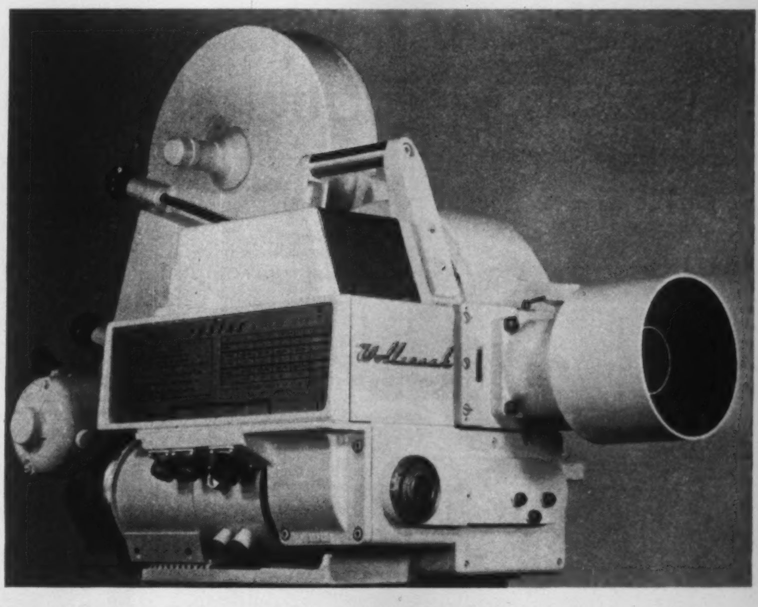

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process optimization conditions. First, completely determinate equations may exist, whose solution by the computer yields optimum controller settings. Second, a completely determinate mathematical model of the process may exist and be stored in the computer's memory, upon which the computer may "experiment" in either real or fast time. Third, only the form of the mathematical model may be available, in which case the computer analyzes the actual process operation in order to keep the model complete and up to date, so that it will provide a correct basis for optimization. Finally, with very little knowledge about the process, the computer may be programmed to perform carefully designed experiments upon the process itself, thus seeking out the optimum controller settings.

The digital computer which provides these various functions was designed by the Transac Div., Philco Corp., to Leeds & Northrup specifications, in a jointly sponsored development. It is a general purpose, serial, internal binary, fixed-point stored program computer.

Parity check is used on all data transfers from main memory. Operator can elect to have parity error stop computation, or, in the case of instructions, to cause automatic reread. Any multiple of 4000 words can be protected in main memory by disabling the associated "write" amplifier. Programs stored in this section cannot be altered by random errors.

System reliability is obtained not only through reliable circuits, but through reliable application techniques. There are programming techniques available which will enhance the reliability of the computer itself. These techniques include such items as reasonableness and redundancy checks, detection of incorrect program jumps and endless looping, and arithmetic checks.

There are two basic digital outputs from the computer. One output is used to control and transfer data to the printers. The second output is used to control and transfer data for all control functions—addressing scanners, actuating annunciator lights, actuating *On-Off* outputs, and adjusting analog outputs.

The number of logging printers will vary according to system requirements. In the majority of applications two printers will be sufficient; one printer for scheduled and on-demand printouts, and one printer for off-normal logging. Annunciator lights actuated directly from the computer will indicate such items as operating guide off-normals, rate of change off-normals, and changes in the mode of process control.

Analog outputs are available to provide process control by the readjustment of local analog control loops. To obtain the maximum reliability, a stepping motor is used to adjust each local analog controller. Each motor can be addressed directly by the computer. When a motor is selected, a pulse train is developed to rotate the motor and increase or decrease the control set point as required.

The circuitry for controlling stepping motors has been designed to enforce a "reasonableness" criterion upon the change demanded by the computer. This is accomplished by limiting the magnitude of an individual change to a per cent increment. As a further check the set point of each local controller is fed into the system as an analog input. This permits a check of the set point readjustment by the computer.

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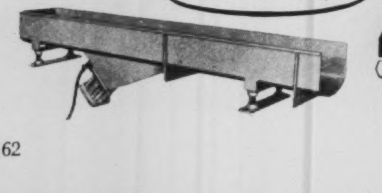

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On-Off outputs are available to allow the computer to start and stop process equipment. The system will normally handle 255 *On-Off* outputs, each of which can be addressed by the computer. The circuits for actuating *On-Off* outputs have been designed to be fail-safe. Two computer signals are required in sequence for an *On-Off* to be actuated. One signal is a set, the second signal is an actuate signal. The same logical circuit is used for both the set and actuate signal. The state of the logic circuit for the set signal is inverted from the state during the actuate signal. Unless all the logic circuit can assume both the *On* and *Off* states, no *On-Off* output will be actuated.

From a paper entitled "The LN 3000 Computer Control System" presented at the Winter Meeting of the American Institute of Electrical Engineers, New York, Feb. 1960.

SELECTING COMPRESSED AIR SYSTEMS

By J. E. MOODY
Joy Mfg. Co.
Pittsburgh, Pa.

DURING the past 60 years compressed air has been playing an ever-increasing role in the manufacturing of all goods. Today, for most plants, the compressed air system shares the spotlight with electric, steam, and water systems. In sizing these utilities for a new plant, the amount of compressed air required is, without a doubt, the hardest decision to make. There is no magic "cfm per square foot of plant area" formula to use.

Listing air using devices: First, it will be necessary to obtain from the Production Department a complete list of all air using equipment. This will include pneumatic tools, machines which use air, paint spray booths, etc. The list should be set up by departments and itemized by type and quantity. The next step is to determine how much air each tool or machine will use. For some of the more common tools an approximate amount of air required can be found in tables. For other machines or tools it may be calculated or obtained from the manufacturers.

Load factor: Very few pieces of machinery using air will be operated 100 per cent of the time. This is especially true with small pneumatic tools operated by hand. It would be foolish to assume that 50 screw drivers, each using 20 cfm, required a total of 1000 cfm for that department. Therefore, a factor must be found which represents the percentage of time these tools are actually using air. As an example, consider metal drills and screw drivers used in small parts assembly. Here the screw drivers and drills may be used by the same man. He might drill a series of holes, put down the drill, and pick up the screw driver. The load factor, to start with, is 50 per cent.

However, as it is necessary to put the screws in by hand before they are driven, the factor is cut down to, say 30 per cent. In drilling the hole or driving a screw, this operation takes only a few seconds, and the air is

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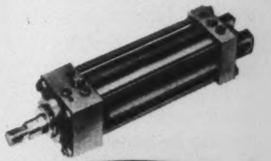

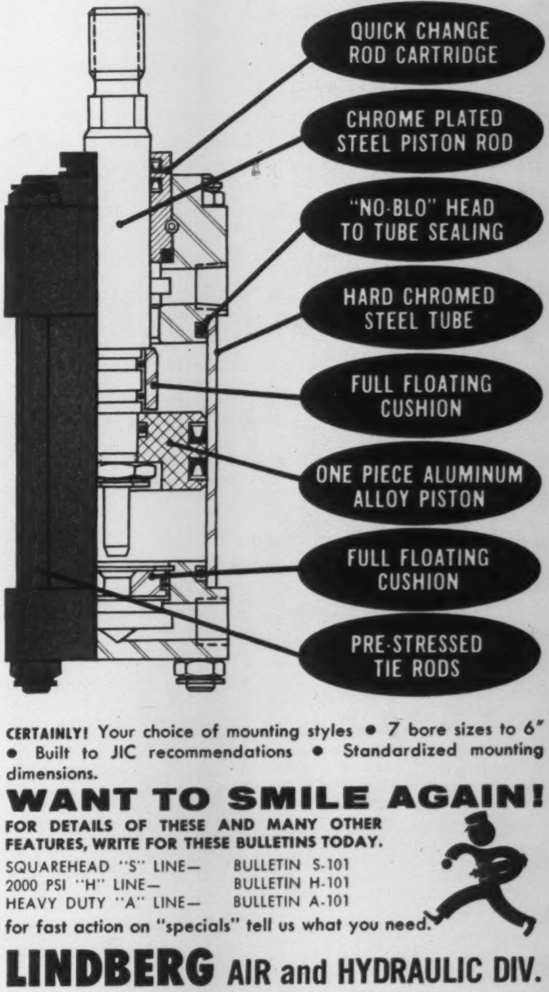
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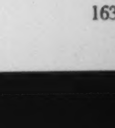

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shut off until the next one is started; now the factor is 15 per cent. Last, the fact that no man works steady for eight hours must be taken into consideration. Time is consumed in rest periods, smokes, talking, etc., so in the end a factor of 10 per cent is arrived at.

The above example holds true, to a greater or lesser degree, with all pneumatic tools and the load factor must be found for all types of air using equipment. This is the most important part of the total calculation. One could miss the amount of air used for a piece of equipment by 10 to 20 per cent without causing too much of an error, but because the load factor may vary from 5 to 100 per cent a careful study should be made in conjunction with the production personnel.

Selecting compressors: When the total amount of air has been calculated, consideration must be given to loss of air through leaks, waste, and future expansion. In a new plant with a good, tight air system, 10 per cent should be added for loss and at least 25 per cent for errors in calculations, or machinery overlooked.

In arriving at a decision as to whether one, two or three units should be purchased, several questions should be considered, as follows:

1. If one unit is purchased, what would happen to plant production if the compressor is shut down?
2. Will the plant operate 8, 16, or 24 hours a day? Will it operate 5, 6, or 7 days a week?
3. What is the availability of spare parts and service?
4. If two or three units are purchased, how much of the plant can work on 50 or 60 per cent of the air capacity?
5. How long will it take to get the plant into full operation?
6. What is the comparative cost, for instance, of one 400-hp, two 200-hp, or three 150-hp compressors with accessories?

Selecting accessory equipment: In a type of industrial plant where there are a lot of small induction motors, power factor correction will have to be added. One of the best and cheapest ways to do this is by using a synchronous motor drive for the compressor. To get maximum results this should have a 0.8 power factor. In selecting the voltage some savings in copper and transformer loss may be obtained by using 2300 volts, but starting equipment may cost more.

Most synchronous motors are started with full voltage across the line starters. For safety, ease of installation, and protection against the elements these should be floor mounted in NEMA type 1 enclosures. Excitation is usually furnished by the use of motor generator sets for flange mounted motors and V-belt exciters for foot-mounted motors.

While it is cheaper to buy one large aftercooler to handle two compressors, it too will need maintenance, and practice shows that separate aftercoolers are safer. In installing these, a bypass should be used so the air compressor will not have to be shut down when the cooler is worked on.

Air receivers fall under the pressure vessel code and must be built to ASME or Massachusetts Standard Code. They are of standard size and can be selected from textbooks. Very little attention is required except for rare insurance inspections. One receiver can be

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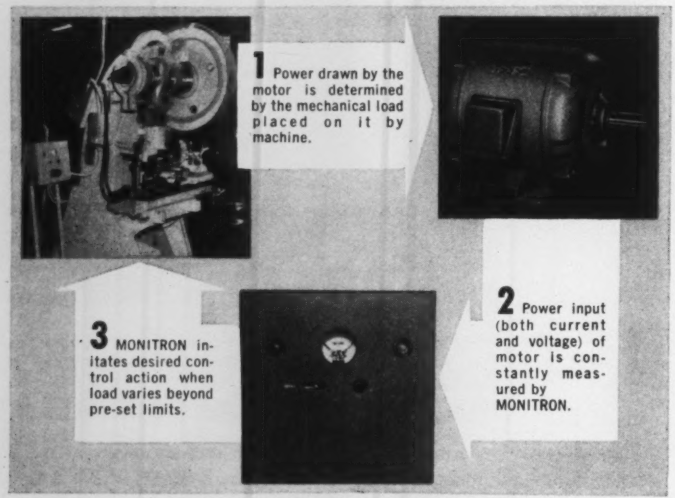

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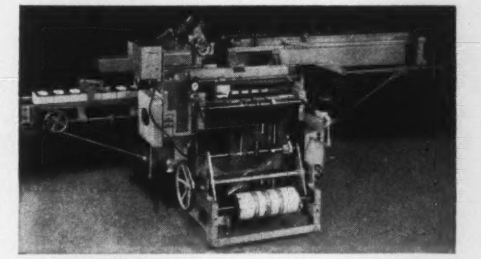

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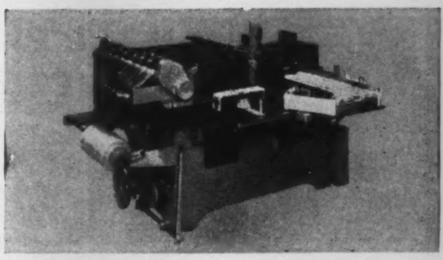

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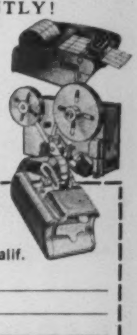

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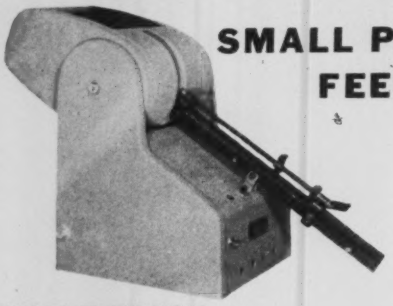

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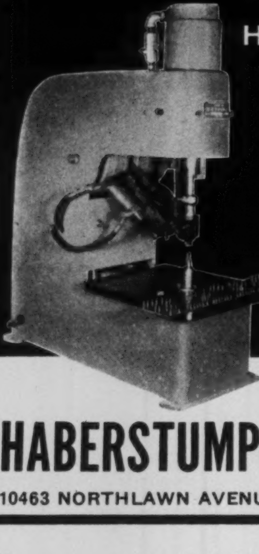

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used for two compressors. It will be advisable to add a second unit when a third compressor is purchased.

Air filters can remove the dust and grit from the incoming air. This, if not removed, will be detrimental to the compressor. If the air filters are to be mounted close to working personnel or other buildings, it is recommended that a filter silencer be used. This will cut down the noise level about 50 per cent.

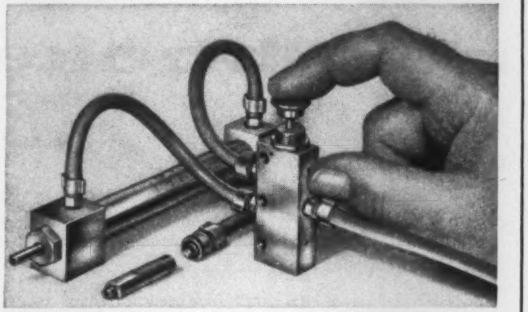
Many compressors come equipped with low oil pressure switches which will shut down the unit in case of low oil pressure. These should be specified. It is also recommended that some type of protection be furnished against water failure. Receivers are equipped with safety valves, but if a bypass is used around the aftercoolers or if any hand valve is installed between the compressor and receiver, a safety valve *must* be placed between the compressor discharge and hand valve. All safety devices, except the valves, can be wired up to lights or warning horns.

Buying & Installing: A lot of time will be saved both for the person buying equipment and the salesman if a complete inquiry is sent out. After the inquiry is sent out, work should start on the compressor room layout. There are a few general rules to remember. The compressors should be arranged to save space but they must be far enough apart to allow proper maintenance. Consideration should be given to the pulling of intercooler tube nests, piston rods, and motors. Room should be left for future compressors. The air filter should be mounted outside and on the north side of the building if possible. For every 10 F drop in temperature of air coming into the compressor, an actual increase of 2 per cent in delivery is obtained. However, the intake line should be kept to a minimum; it should be the full diameter of the intake on the compressor, and if more than 15 feet long, use the next size larger pipe. The aftercoolers can be stacked one on top of the other with a bypass between them. The placing of pipe in trenches, such as water, air discharge, and drains, is recommended.

It is very important that the main air line be sized to take the entire load plus future expansion. Tables showing pressure drop are found in the *Compressed Air Handbook*. The loop system is always recommended. This allows use of smaller pipe and assures a more equal distribution of air throughout the plant. It is also recommended that this loop be tied together somewhere in the middle of the plant and that the entire loop be equipped with valves so various sections can be shut off while new connections are being made. Moisture and oil moves along the pipe at a speed depending upon the velocity of air. If this velocity is kept low enough, most of the liquid will flow along the bottom of the pipe. Outlets should always come off the top to prevent carry-over. Drain legs should be installed several places in the loop. Effective drains can be made by simply dropping a piece of pipe, the same size as the main line, down close to the floor. This can then be tapped and a small $\frac{3}{4}$-inch pipe with a valve put in it.

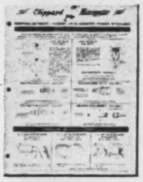
From a paper entitled "Selecting and Installing the Proper Size Air Compressor for a New Plant", presented at 15th Annual Meeting of the National Conference on Industrial Hydraulics, Chicago, October, 1959.

NEW! MORE Powerful 9/16" MINIATURE AIR CYLINDERS • 4-WAY AIR VALVES • QUICK CONNECTS



NEW more powerful 9/16" bore spring return and double acting MINIATURE Air Cylinders to complement our widely used 3/8" bore cylinders. NEW 4-way Air Valve, Quick Connects, A.C. and D.C. Valve Operating Solenoids. NEW MINIATURE Flow Control, Needle and Check Valves, fittings, mountings and accessories to improve your automatic production and tooling devices or new end products where savings in cost, weight or space are MUSTS. Made for MILLIONS of cycles of trouble-free operation.

Write for NEW Bulletin No. 459



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Manufacturers of R. F. Coils, Electronic Equipment, Miniature Pneumatic Devices

Circle 753 on Page 19

LITTELL Style "M"

The "Install-it-Yourself" Roll Feed That Makes Medium Duty Presses Up to 5 Times More Productive!

TODAY'S ORDER SHIPS TOMORROW!

Install the Style "M" yourself. Three steps.

1. **Cut and thread the connecting rod.**
2. **Bore and install the disc hub.**
3. **Fabricate and mount lifter bracket.**

Simple Instructions in Bulletin 702 furnished with your order make installation easy. 5 sizes. Maximum stock widths, 4" to 12". Left to right feed. Feed lengths, 0-2" through 0-4⅜" with plain gears, and 0-4½" through 0-8½" with compound gears. Engineered feeds with all parts complete are delivered in 4 weeks.

Write for Catalog "A"

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SERVING USERS OF COIL STOCK

Branches: Detroit Cleveland

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Circle 755 on Page 19

NEW DIXON AUTO-TORQUE *Driver*

SCREWS AND NUTS AUTOMATICALLY DRIVEN WITH PRECISE TORQUE CONTROL

Gives you . . .

1 Complete control of screws from parts feeder to chuck, until threads are started. No dependence on gravity to load chuck.

2 Exclusive built-in sensing, assures that screw is driven. Automatically retracts driver only after attaining proper torque.

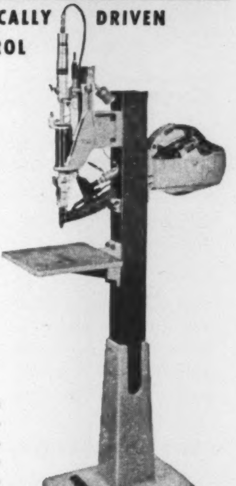
3 Complete automatic cycle, requires only a touch of the pedal.

4 Torque accuracy within 5%, comparable to most precise hand-torquing methods.

5 Clutch free-wheels after driving. Operator cannot vary the torque.

6 Two ranges of torque available 0 to 84 inch-pounds and 48 to 120.

7 Work height adjustment with 14" range, can be made without in any way disturbing the machine adjustments.



The new DIXON *Auto-Torque Driver* includes all the features of the DIXON Auto-Positioner, .and has an efficient space-saving air motor with an adjustable-torque clutch. These features provide for *positive* handling, giving new efficiency in driving screws and nuts.

Full information available in bulletin No. SD-81.

Model SD-100, above, tooled for any standard screw up to 5/16" thread size. Special tooled units with multiple feeders available. Model SD-101, without floor column, provides a complete automatic station. Maximum width 6 inches.

DIXON AUTOMATIC TOOL, INC.
2312 - 23rd AVENUE
ROCKFORD, ILLINOIS

DIXON

EQUIPMENT FOR AUTOMATIC PARTS HANDLING AND ASSEMBLY

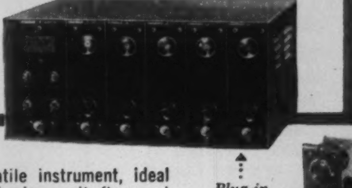
Circle 754 on Page 19

TALLY-COUNT®—*an electronic*

PREDETERMINING COUNTER

Standard 2-decade model:

$245⁰⁰



Plug-in decades (up to 5) $50 each

TALLY-COUNT is a versatile instrument, ideal for batch counting, packaging, unit flow and machine cycling. Tally-Count provides electronic speed and accuracy, at a price usually associated with electro-mechanical counters.

unique chassis design for plug-in sensing devices

A wide range of photoelectric and other sensing devices extends Tally-Count versatility. These devices plug into amplifiers, which can be incorporated as integral elements of the chassis. Tally-Count supplies all power for these sensing devices. No other power supply is needed.

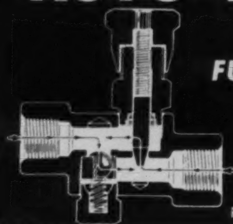
Tally-Count operates accurately at speeds up to 100 per second. Batching capacity (5-decade model) is 100,000. Instantaneously resets to zero at desired count. Double and triple pre-set models available.

For full details, write for Brochure LC-4.

standard INSTRUMENT CORPORATION
657 BROADWAY, NEW YORK 12, N.Y.

Circle 756 on Page 19

AUTO-PONENT®



HYDRAULIC
FULL FLOW VALVES

Flow Control, Needle, Check, for HYDRAULIC Power

Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841, 174

A complete line: 1/8", 1/4", 3/8", 1/2", and 3/4" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

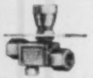
EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

Model F Standard Flow Control Valve or Model N Needle Valve

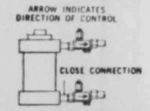
Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.



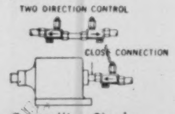
Model PF Knob and Dial Flow Control Valve or Model PN Needle Valve for panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder



Controlling Single Acting Cylinder

AUTOMATION
AUTO PONENTS INC
COMPONENTS

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BELLWOOD (Chicago Suburb) ILLINOIS

Circle 757 on Page 19

NEW JUNIOR SIZE VIBRA-WASHER

GIVES YOU AUTOMATIC PROCESSING OF METAL PARTS

- LABOR SAVING
- READILY ADAPTABLE TO MANY OPERATIONS
- NO NESTING OF PARTS DURING CLEANING OR CONDITIONING CYCLE
- ADJUSTABLE CAPACITIES
- ELECTRIC—GAS—STEAM HEATING ELEMENTS

Simplicity

The new Simplicity Junior Size Vibra-Washer employs a vibrating work carrier that automatically conveys metal parts through a cleaning or conditioning bath. It cleans so thoroughly that chips, oil and grease are removed from even blind or slotted openings; cleans so gently even the most delicate threads or flanges are not harmed.

If you have a tough cleaning or conditioning job, Simplicity Engineering Company can help. For information, write or call the Industrial Washer Division.

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FOR CANADA: Simplicity Materials Handling Limited, Guelph, Ontario

AUTOMATION new books

MACHINERY'S HANDBOOK—16TH EDITION

By Erik Oberg and F. D. Jones; 16th edition edited by Holbrook L. Horton; 5 by 7¼ inches, 2070 pages, published by The Industrial Press, New York; available from AUTOMATION; *$11.00 postpaid.*

This standard reference work has been improved by what the editor describes as "the most extensive revision in over twenty-five years." Recent or revised engineering standards, both American and British, are included, together with a large amount of general information and mechanical data representing the latest design and manufacturing practices.

ANALYSIS OF LINEAR SYSTEMS

By David K. Cheng, professor of electrical engineering, Syracuse University; 431 pages, 6¼ by 9¼ inches, published by Addison-Wesley Publishing Co. Inc., Reading, Mass.; available from AUTOMATION; *$8.50.*

The importance of the Laplace transform method in analyzing linear systems is well documented. Those engineers and students who have been somewhat mystified as to the development of this useful mathematical technique will appreciate the approach taken by the author in discussing the solution of linear differential and integrodifferential equations. The text is oriented toward electrical circuits, but a chapter on analogous systems is included which discusses formation of electrical circuits that are analogous to linear mechanical and electromechanical systems.

Association Publications

AMERICAN DRAFTING STANDARDS MANUAL, SECTION 17, FLUID POWER DIAGRAMS

Available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; paperbound; 24 pages, 8½ by 11 inches; $1.50.

American Standard Y14.17-1959 is one of 18 sections of the American Drafting Standards Manual. This section establishes drawing practices to be used in depicting systems which use a liquid or gas within enclosed circuits to transmit and control power. Pictorial, cutaway, graphical, and combination types of diagrams are covered.

WHY AUTOMATION?

Available from National Office Management Association, 1931 Old York Rd., Willow Grove, Pa.; paperbound, 15 pages, 8½ by 11 inches, contains tabular data; free to members of NOMA, $5.00 to nonmembers.

Report summarizes a survey of experience of 369 companies with data processing machinery installations. The paper includes a bibliography of selected articles, booklets, reports, and books published on the subject of automation in data processing.

Circle 758 on Page 19

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offer you these outstanding features for your flowable material:

- Completely flexible
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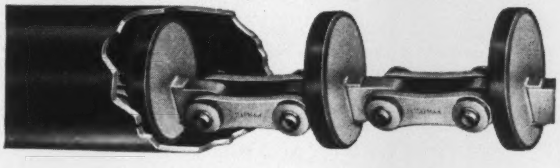

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... but return their cost many times. Sound engineering, superior materials and workmanship go into every Hapman installation. With Hapman tubular conveyors you have minimum wear, minimum degradation, and maximum trouble-free performance. This is why you may pay more initially, but with Hapman you can be sure of the best conveying system . . . and save in the long run.

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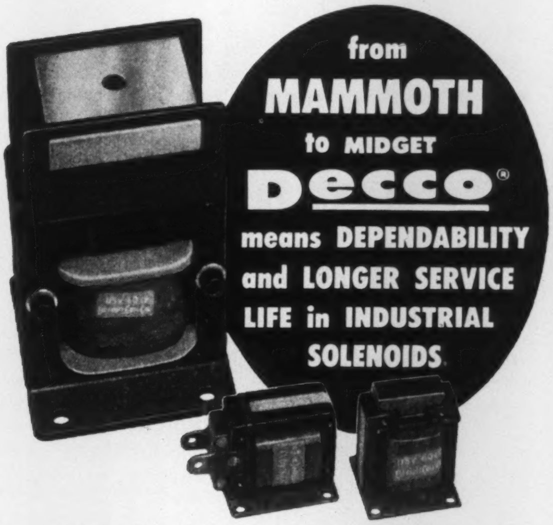
Circle 759 on Page 19



DECCO solenoids' unique engineering features and top quality materials have greatly extended their service life.

There is a DECCO solenoid to meet your requirements. Oil immersed, push or pull, shock mounted, A.C. or D.C., mammoth or miniature, they have to be good to be DECCO. Write for catalog.

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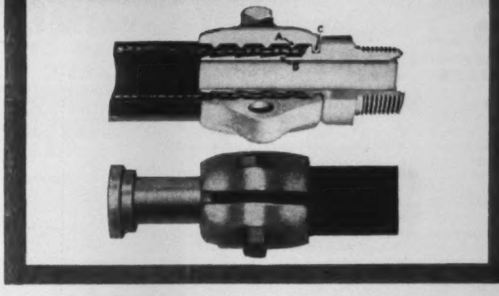
Circle 760 on Page 19

Clamp Couplings

with Exclusive Inter-Lock Features



Only EASTMAN Clamp Couplings offer you the exclusive "Inter-Lock" feature shown in cutaway view above:

Outside rib of clamp locks in groove of hex (C) assuring precise positioning of each rib of clamp (A) between each barb of insert (B).

Because hose is uniformly compressed between alternating ribs and barbs, it cannot be weakened and will give your customers longer service.

Only EASTMAN offers you this exclusive combination: Inter-Lock Clamp Couplings with Split Flange Head for a No-Thread, No-Leak, "O" Ring Connection.

WRITE for Technical Bulletin 100 on Low and Medium Pressures.

Eastman MANUFACTURING COMPANY
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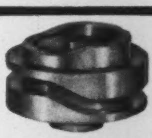
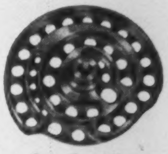
Circle 761 on Page 19

PRECISION CAMS
and
CAMSHAFTS
All Types . . . Experimental and Production



Special Drum Type Cam

TWO AND THREE DIMENSIONAL CAMS
for Ballistic, Computer and Instrument Use—Milled or ground to ± .0001″ tolerance



Face Type Cam

FACE AND CYLINDRICAL CAMS
milled or ground to ± .0002″ tolerance

CAMSHAFTS
Aircraft, Automotive, Diesel Marine, Fuel Injection

Camshaft for Internal Combustion Engine

EONIC Inc. Engineers of Precision

Write for catalog and additional information

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Circle 762 on Page 19

Get Easier, More Accurate Cylinder Speed Control

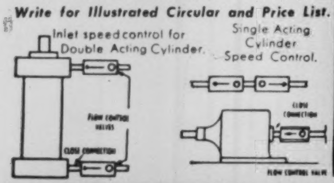
PNEU-TROL
BELLWOOD, ILL.
2,841,174

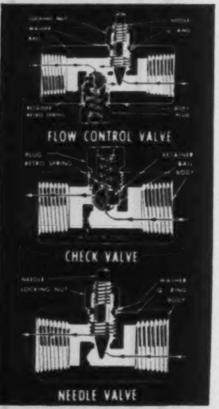
with **Pneu-Trol**® VALVES IN AIR OR HYDRAULIC USE

2,000 (brass or aluminum) and 5,000 (steel) p.s.i.

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 5 female pipe sizes — 1/8" to 3/4". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

Write for Illustrated Circular and Price List.


Inlet speed control for Double Acting Cylinder.
Single Acting Cylinder Speed Control.
FLOW CONTROL VALVES
CLOSE CONNECTION
CLOSE CONNECTION
FLOW CONTROL VALVE


LOCKING NUT
WASHER
BALL
NEEDLE
O RING
RETAINER
RETRO SPRING
BODY
PLUG
FLOW CONTROL VALVE
PLUG
RETRO SPRING
RETAINER
BALL
BODY
CHECK VALVE
NEEDLE
LOCKING NUT
WASHER
O RING
BODY
NEEDLE VALVE

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Circle 763 on Page 19

MINIATURE AGASTAT
AGASTAT
2112-D-H1
28V DC
.030-10 SEC.
3 SEC.
M 500

Now! get complete data on

MINIATURE AGASTAT®

time/delay/relays

This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1½", with adjustable timing ranges starting at .030 and as high as 120 seconds.

The folder gives operating and environmental specs, coil data, contact capacities, dimensions, diagrams of contact and wiring arrangements. *Write:* Dept. A33-423.

AGA DIVISION **ELASTIC STOP NUT CORPORATION OF AMERICA**

Elizabeth, New Jersey

Circle 764 on Page 19

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2015-P

ASSEMBLING LOOSE LEAF METALS

. . . We are interested in contacting companies who have had experience in furnishing automatic equipment for production of loose leaf metals. As a problem of the moment, we wish to assemble parts into a subassembly which consists of three formed metal arches (one-half of the ring binders in a typical loose leaf folder) that are oriented in holes spaced along a strip metal frame and then staked in place. We envision the arches being hopper fed onto a track and delivered to an escapement, with the tang position of the arch uppermost. The parts would be transferred to a die and locked into position; subsequently the arch frame would be located over the exposed tang and the press dropped. We desire to feed the arches at a rate of 30 per minute.

Methods Engineer

CASE 2012-P

GAGING PLASTIC BALLS

. . . We manufacture polystyrene balls. We would like to contact a manufacturer of a machine which will automatically feed and gage these balls. The diameters of the balls range between 0.700 to 0.750 inch; tolerance on the diameter is plus or minus 0.002 inch . . .

Assistant Chief Engineer

CASE 2017-P

ZERO SPEED SWITCH

. . . We have a rotary type kiln dryer which turns at approximately 6 rpm. It is essential that the fire under the dryer be turned off immediately when the dryer stops turning. We need a device which will indicate remotely if and when the dryer stops turning. We would appreciate the name of any company who makes and markets such a device . . .

Assistant Design Engineer

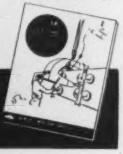
CASE 2013-P

VISCOSITY CONTROL

. . . I need a control device which will detect a change in the viscosity of a material in a mixing machine. My plan is to detect a change in the current flow into the motor driving a mixing pump. Depending on the change in current, either a solenoid valve controlling liquid flow or a switch controlling a dry materials feeder would be actuated to maintain the desired viscosity. What companies make such a control device as I have outlined? . . .

Superintendent, Assembly Dept.

VAC-U-MATION®...



... offers you SAFETY and economy of feeding and ejection

PRES-VAC SAFETY FEEDERS feed blanks to press from a safe distance of 14 inches—BY AIR!—maximum protection to operators and handling costs kept at a minimum.
Save those fingers. $35.00

AIR BLAST VALVES eject parts safely with each stroke of the press—BY AIR!
Save those hands. $29.00

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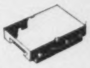
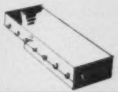
4583

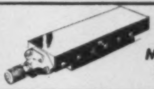
LITTELL
VAC-U-MATION DIVISION
4105 Ravenswood Avenue, Chicago 13, Ill.
District Offices: Detroit and Cleveland

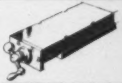
Circle 765 on Page 19

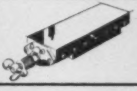
Gilman PRECISION SLIDE ASSEMBLIES ...available FROM STOCK in 132 standard types and sizes

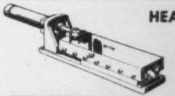


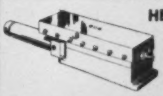












LIGHT DUTY BASIC TYPE	HEAVY DUTY BASIC TYPE
LIGHT DUTY TYPE WITH RETURN SPRING	HEAVY DUTY MICROMETER STOP TYPE
LIGHT DUTY LEAD SCREW TYPE	HEAVY DUTY LEAD SCREW TYPE
HEAVY DUTY CYLINDER POWERED (in-line mount)	HEAVY DUTY CYLINDER POWERED (lower mount)

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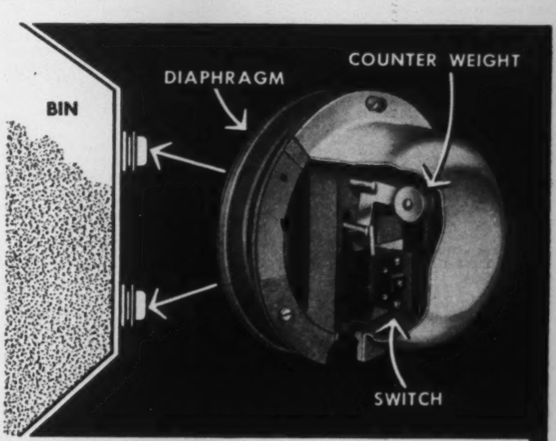
Circle 766 on Page 19

AUTOMATION
annual
product
review

Looking for some new ideas?

You'll find them fast in this FREE 36-page booklet. Contains complete, concise reviews of automation equipment, products, components and services advertised in AUTOMATION during the 12 month period October 1958 through September 1959. Describes 400 separate items; indexed for fast, easy reference. Limited quantity on hand, so write for YOUR free copy NOW!

AUTOMATION
Penton Building
Cleveland 13, O. Dept. P.



BIN-DICATOR® PAYS FOR ITSELF FIRST TIME IT PREVENTS BIN OVERFLOW, CONVEYOR CLOG, ELEVATOR CHOKE-UP, MACHINERY DAMAGE, REPAIR SHUT-DOWN

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CUMULATIVE EDITORIAL INDEX

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PRAB PRECISION ENGINEERED
Specialized CONVEYING EQUIPMENT

MAGNAVATOR
a magnetic parts elevator

TUBE-VEYOR
an enclosed bulk handling conveyor

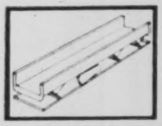
PRAB "Vibra-Power"
OSCILLATING CONVEYORS

PARTS FEEDING CONVEYOR

BUCKET ELEVATOR

Here simplicity of construction results in low initial cost and minimum maintenance. Gentle action allows handling of fragile materials. Because there is no dragging or squeezing, abrasive material can be handled easily. The "Vibra-Power" is sanitary—inherently self-cleaning and can be totally enclosed to eliminate dust, liquids, smoke or germs.

Materials Handled Include:
Welding Flux • Sand • Coal
Sawdust • Castings • Corn
Fertilizers • Cast Iron Chips
Scrap Turnings • Limestone
Cement • Stampings • Sugar
Glass Cullet • Ice.



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STEEL BELT CONVEYOR

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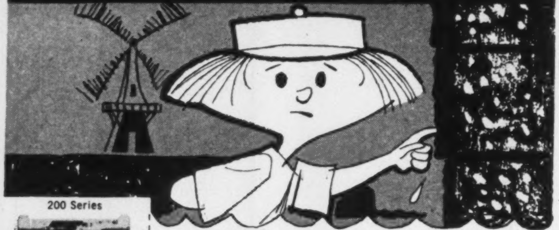
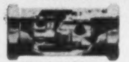
Too bad the Dutch Boy never had it so leakproof!



200 Series

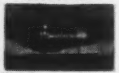


Standard Service
0 to 3000 psi

100 Series

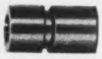
Ultra Sensitive Service
0 to 25 psi

2300 Series



High Pressure Service
0 to 10,000 psi

Cartridge Type



Manifold Block
Assembly Mounting

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A finger in the dike may have solved the Dutch Boy's dilemma but today's precision-minded engineers insist on *complete leak-proof* performance for their sealing problems. That's why engineers specify Circle Seal.

Put your finger on the perfect solution to leak-proof check valve performance. Circle Seal check valves will meet your requirements in pressures from 0-10,000 psi for nearly all types of service—liquid or gas. Positive sealing at any differential pressure. Quick opening—positive closing. Maintenance-free dependability. You don't need a Dutch Boy when you specify Circle Seal Valves!

Complete engineering data available from:

CIRCLE SEAL
precision valves

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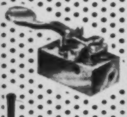
free catalog



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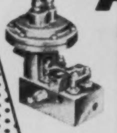
VALVES
The A. K. ALLEN CO.

ALLENAIR VALVES



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Company ....

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AU-4

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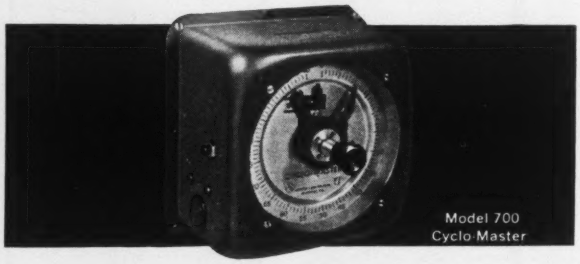
STANDARD MODEL FOR

ONE-COUNT SWITCHING
ONE-CYCLE SWITCHING
DIFFERENTIAL COUNTING



Model 700
Cyclo-Master

use the new Cyclo-Master

continuous cycling preset counter and controller

- Counts electric impulses at speeds up to 1000 cpm
- Single-knob dial settings from 1 to 100 counts
- Recycles with absolutely no interruption of counting process
- Quick manual reset to zero • Wall or panel mounting
- **Applications in control of:** automatic reversing, batch counting, box-making machinery, container filling, instrumentation, punch press cutoff, roll sizing, sheet counting, paper converting machinery, packaging machinery, interval indication, linear measuring, adding and subtracting to preset maximum and minimum limits, etc.

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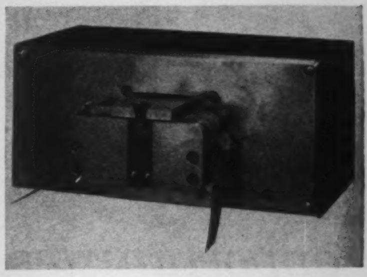

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SPEED: Up to 10 frames per second.
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PURDUE
CONFERENCE?

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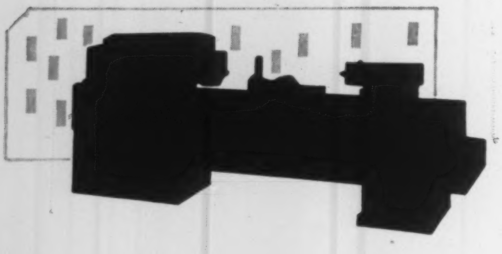
for Reservations
and
Conference Details



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THROUGH
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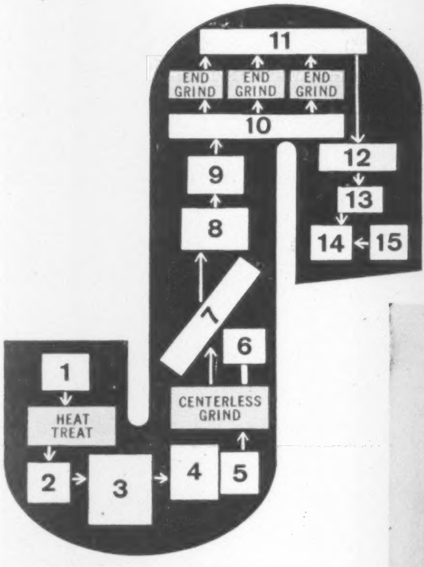
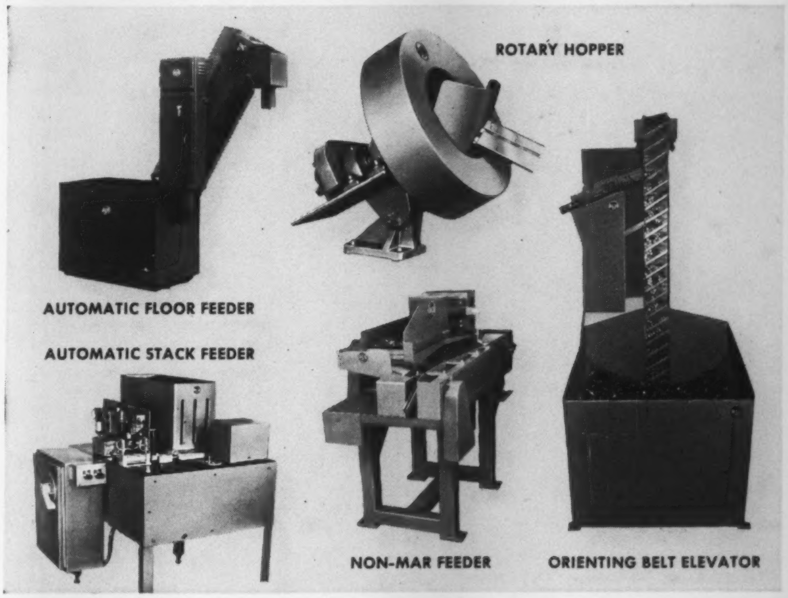


For peak efficiency...

Select the RCA feeder that best meets your job requirements



Flow diagram showing typical applications of

RCA AUTOMATION

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2. RCA Elevating Orienting Feeder
3. RCA Automatic High-Speed Hardness Testing Machine
4. RCA Floor Feeder
5. RCA Rotary Hopper
6. RCA Grinder Control
7. RCA Transfer Conveyor
8. RCA Non-Mar Feeder
9. RCA Mechanical Orienting Machine
10. RCA Demand-Feed Conveyor
11. RCA Conveyor
12. RCA Final Inspection Machine
13. RCA Non-Mar Feeder
14. RCA Automatic Assembly Machine
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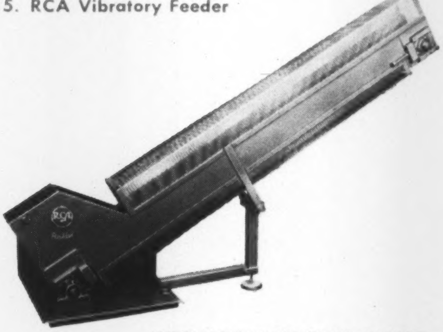

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Feature Dead Tight
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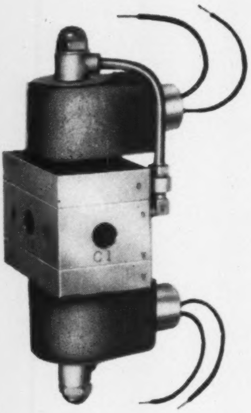
ELIMINATE PISTON DRIFT



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